2.0 BASELINE RESOURCES

2.1 Habitat Factors

Numerous physical and biological factors have interacted to shape the natural terrain and wetlands of the Santa Rosa Plain prior to human settlement, as well as the human-oriented landscape that has formed since that time. Current conditions reflect human settlement's impacts on the natural landscape, with only scattered remnants of pre-settlement conditions. The primary physical factors which led to the evolution of the vernal pool and oak savanna ecosystem on the Plain include the valley's underlying argillic (dense clay) horizons and high clay surface soils, the relatively flat topography, ample winter precipitation, and dry summer climate. The natural result of these physical factors is a vast network of seasonally wet swales and scattered pools within overall grassland and savanna. In the wetter habitats, there came to be an extensive niche for specialized wetland species, and a rich wetland flora has colonized and evolved in these environments. These wetlands support common and widespread plants, as well as regionally restricted (endemic) species. Built upon the natural wetland and grassland habitats were intricate communities of aquatic invertebrates, amphibians, waterbirds and waterfowl, including herbivores, predators, and grazers. Over time, complex interrelationships evolved between species and habitats, resulting in an unique valley ecosystem. Much of this natural ecosystem was eliminated from the Plain, however, before it could be studied or understood.

While soils, topography, and precipitation (combined with natural biotic evolution) dictated the pristine landscape's natural character, factors related to modern land use have fragmented the study area's wetlands and created a much-changed ecological scenario. The native flora and fauna have been greatly depleted by agricultural development, and continued farming, ranching, and other land uses (e.g., residential development) preclude recovery of the natural communities. A major factor in effect here is the large physical area involved in largely incompatible uses. Since the physical processes that fostered the native flora and fauna are still in effect, however, considerable opportunities for restoration exist.

2.1.1 Soils

The Santa Rosa Plain is situated in a broad structural trough referred to as the Cotati Valley. The creation of this valley was brought about by the uplift and tilting of large, regional-scale structures (Higgins, 1952). The low hills of the Merced formation on the west side of the valley and the volcanic Sonoma Mountains to the east have uplifted as the valley floor has sunk. The down-faulting of the Plain, which began approximately one million years ago during the Pleistocene epoch, has helped create the very low gradient of the Laguna de Santa Rosa and its tributaries.

The predominant geologic units in the Cotati Valley are the early and later Pleistocene alluviums. These older deposits occur as remnants of dissected alluvial terraces laid down by streams eroding the volcanic Sonoma Mountains to the east. These deposits underlie the gently undulating expanse of the Plain and support oak savanna, valley grassland, and seasonally wet drainage swales and vernal pools. North of Santa Rosa Creek, the underlying material is early Pleistocene alluvium (70,000-1.8 million years old) and corresponds with the Huichica loam soil series. South of this creek, the alluvium is late Pleistocene (10,000-70,000 years old) in origin and corresponds to the Wright loams. (Miller et al, 1972)

Another extensive unit in the valley includes the extremely fine-grained alluvial (clay) deposits that best reflect the regional wetlands' origins (Helley et al., 1979). These deposits correspond with the Clear Lake clay soil series. North of Highway 12, the boundaries of this deposit closely parallel the present and historic distribution of riparian forest and perennial marsh. South of Highway 12, this fine-grained alluvium was associated with historic seasonal and perennial marshlands that are now the sites of urban development in the Rohnert Park area as well as extensive agricultural development (Cardwell, 1958).

The study area contains four major soil series, all of which are characterized by high clay content either throughout the profile, such as in Clear Lake clay, or as buried layers. A few areas exhibit cemented alluvium (generally with some clay) as an underlying restrictive layer, but most of the region's buried restrictive layers are simple heavy clay. Silica-cemented alluvial layers and other types of hardpans are not common in this region. The primary soils form a wide geographic expanse of poorly and somewhat poorly drained soils. Table 1 summarizes the regional soils that are generally prone to seasonal ponding or prolonged saturation, and Figure 4 shows the extent and distribution of the generalized soil series. The following are brief descriptions of the study area's primary soil types, based on descriptions given in the Sonoma County Soil Survey (Miller et al., 1972) and unpublished field investigations made by the report authors.

Clear Lake Clay - Clear Lake clay is a Vertisol soil found on floodplains and flat basin areas, generally on the southern part of the Plain and close to the Laguna de Santa Rosa. It is a "shrink-swell" clay that is very dark and high in organic matter because the original soil genesis was under marsh conditions which contributed a large amount of dead vegetation. Its origin is relatively recent (10,000 years) having formed in closed basins in which fine sediments were deposited and marsh vegetation was added (Helley et al., 1979). The soils are typically greater than five feet deep and consist of dense clays and clay loams underlain by gravels or sandy loams.

This soil is poorly drained, permeability is very slow, and runoff potential is high. Topographic variations and lack of surface drainage routes typically result in extensive and scattered surface ponding, often from simple direct rainfall and without large watersheds (i.e., less than a few acres). Early season rains penetrate the surface horizon via an extensive network of dry season shrinkage cracks, with surface ponding occurring with relatively little cumulative precipitation as the soil wets, swells, and the cracks close. There is generally no subsurface or perched water table in this soil, and wetlands are largely dictated by simple topography and drainage patterns. Historically, riparian forests, perennial marshes and seasonal wetlands have been associated with Clear Lake clays (Waaland, 1989; Waaland et al., 1990). Much of this soil has been artificially drained and cleared of the native vegetation for cultivation of corn, grasses and hay. Large areas have also been subjected to urban development. Clear Lake clay is predominant in the Cotati, Rohnert Park, and southern Santa Rosa areas.

Wright Loam - The Wright soils are the most extensive in the study area (see Figure 4 and Attachment 3). They are derived from weathered alluvium deposited during the late Pleistocene epoch (10,000 to 70,000 years ago). These soils have undergone formative processes longer than other soils in the Laguna and have subsoils in which clay has accumulated. The soil is five or more feet deep with two feet of loam or sandy clay loam underlain by clay or a clay hardpan. The wet phase of the Wright loam is the typic phase. These soils are somewhat poorly drained, permeability is very slow in the subsoil and drainage is somewhat poor.

The native vegetation of these soils is valley oak savanna with bunchgrasses, with vernal pools and swales interspersed (Waaland, 1989a; Waaland et al., 1990). In the past, many of these soils were used for pasture or cultivated as prune orchards. At present, these soils are mainly used for dry and irrigated pasture and hay crops, as well as sites for urban development. Wright soils occur mainly between western Santa Rosa and the Laguna.

Huichica loam - These soils are similar to the Wright series in that they have a dense clay or argillic horizon that prevents significant downward percolation, and they typically have one to two feet of clay or silty clay loam on top of the restrictive layer. This soil type is predominantly located in the northern part of the study area (northwestern Santa Rosa to Windsor) and includes shallow and wet phases. The surface soil is typically very fine textured, and surface ponding occurs due to both subsurface restriction (perched water table) and topsoil "sealing".

Zamora silty clay loam - This soil is a relatively minor component in the study area and occurs in a broad band across the northern portion of the study area. The Zamora series consists of well-drained clay loams that have a clay loam subsoil formed in recent deposits on alluvial fans along the drainageways of Santa Rosa Creek and other waterways. Permeability is moderately slow in the subsoil and runoff is slow. Typical native vegetation includes grassland and oak savanna, while vineyards, orchards, and pasture are the main agricultural uses of this soil. Other areas have been urbanized.

Because of the Plain's extensive micro-relief, numerous pockets of clay accumulation and other soil complexes are also present (C. Patterson, unpubl. field data; D. Martel, Corps of Engineers, pers. comm.). Most creeks and major drainages are lined with soils high in sand, gravel, and/or cobbles, and most swale/pool terrain exhibits denser clay soil in the lower topographic positions and more silt and loam on the higher ground.

The primary direct alterations to the study area's soils have come from discing, land leveling, and larger scale soil excavation and/or fill deposition. These activities have served to blend the topsoil layers and mix "ridgetop" soils with "swale-bottom" soils. Additional secondary effects have come from irrigation, fertilization, ditching and flood control channelization (dewatering), and localized compaction from grazing and vehicular operations.

2.1.2 Topography

The Santa Rosa Plain has a general slope of only about 0.3 percent (300-to-1) from the east to the west side. Elevations along the base of the eastern hills range from 140 feet in the south around Rohnert Park to 180 feet in the north just east of Windsor. Most of the Plain drains west-southwest to the Laguna de Santa Rosa which flows almost due north to the Russian River after originating at an elevation of approximately 100 feet in the extreme southern part of the study area in the vicinity of Cotati. In the northwest part of the study area, the Laguna is joined by Mark West Creek at an elevation of 50 feet. The Laguna drops only 45 feet over 14 miles (76,000 lineal feet) from its headwaters near Cotati to the vicinity of Mark West Creek, for a gradient of only 0.06 percent.

The bulk of the Plain is between 50 and 130 feet in elevation, with occasional scattered small hills set within the network of subtle swales and small creeks. Slopes within the swale systems range between approximately five percent (20:1) on the steepest swale side slopes, to virtually flat pool bottoms in the larger basins. More typical side slopes and pool bottoms are between 0.5 and 2.0 percent (200-to1 and 50-to-1 respectively), with many areas exhibiting nearly level terrain between the drainage swales.

With high clay soils, poor downward percolation, and very low gradients, much of the landscape is saturated or inundated for prolonged periods during the winter, and topographic variation dictates which sites pond and which experience simple soil saturation and/or sheet flow drainage. Because of the very low east-west gradient, many areas of undisturbed swales form braided systems, with extensive inter-swale connections.

Historic agricultural land use (including grading, ditching, cultivation, and irrigation) and more recent residential development have altered the Plain's topography, generally leveling out the more pronounced undulations and interrupting or eliminating many of the longer swale systems. Even in areas where intentional land leveling has not occurred but cultivation has, the ground surface has lost considerable relief through repeated discing.

2.1.3 Hydrology

General Processes - The hydrologic processes of the Plain include three primary components, including (1) simple overland (sheet) flow, (2) impeded infiltration, and (3) perched water tables. General overland sheet flow results in the collection of runoff across gentle gradients and into low surface features (including pools and swales), and eventually into more well defined drainageways. All watercourses in the study area ultimately drain to the Laguna, although many headwater systems form extensive meandering and interconnected swales before they collect into well defined waterways. On the heavier, largely impermeable soils (e.g., Clear Lake clay), overland runoff is the predominant hydrological phenomenon, although some minor downward percolation does take place. Even on the more porous soils, lateral surface runoff or sheet flow is important during intense storm events when infiltration is limited by the fine textured soils (Miller et al., 1972). Sheet flow operates throughout Plain, on low gradient landscapes and steeper slopes.

Table 1. Summary of primary soils on the Santa Rosa Plain

Soil series	Phases	General Charact r	Typical Hydrology	G neral Drainage Class	Restrictiv Layer ?	Supports Wetland ?	Notable Species or Qualities	Extent in Study Area
Huichica	H. loam, ponded; H. loam, shallow; H. loam, shallow, ponded	fine textured clay loam over buried dense clay & cemented layers; minor shrink/swell; extr. hard when dry	seasonally perched water table (<2 ft deep) above buried restrictive layer	somewhat poorly drained	Yes: dense clay at 10-30 in.; + occ. deeper cemented alluvium & ash	Yes: seasonal saturation and ponding; often shallow or intermittent	LABU; northern part of study area	14,000 ac
Wright	Wright loam; Wright loam, wet; Wright loam, shallow	fine silty loam over buried dense clay & marine sediments; moderate shrink/swell	perched water table (<2 ft deep) above buried restrictive layer	moderately good to somewhat poor	Yes: dense clay at 1.5 to 3 ft.; often to 5 ft. depth; silty clay surface loam	Yes: seasonal saturation and ponding; often with deep, persistent vp.s	LIVI; CTS; middle part of study area	15,000 ac
Clear Lake	Clear Lake clay; Clear Lake clay, ponded; Clear Lake clay loam	dense clay from surface to 5-6 ft. depth; occ. surface clay loam; extreme shrink/swell	seasonally ponded where surficially undrained; often not staurated	'drained' or 'undrained' relative to topography	Yes: hard dense clay from surface to many feet thick; may have surf. loam	Yes: surface ponding once wetted; topographically dictated	Triteleia peduncularis, Lolium, Poa annua, Brodiaea elegans	6000 ac
Haire	Haire clay loam; H. fine sandy loam hummocky	clayey loam over clay subsoil and cemented valley alluvium	seasonally perched water table above restrictive layer	moderately well drained	Yes: buried clay layers, plus clayey surface soil	scattered		2000 ac
Zamora	Z. silty clay loam	loam & clay loam over clay loam subsoil and recent alluvium; scattered clay lenses, fine texture	intermittent saturation; occasional perched water table	well drained	Yes/No: subsoil is clay loam, not clay; scattered clay lenses	Yes/No: some areas become saturated, others drain	not reliably wet; may be without wetland character in dry years	4000 ac urban, alluvial fans
Other potential wetland soils:	Cotati fine sandy loam; Yolo clay loam; Pajaro clay loam riverwash; Los Osos clay lm.	surface loams over buried clays; scattered water tables over buried clay; some may be well drained	seasonal saturation and perched water tables; scattered ponding	moderately well drained to somewhat poorly	Yes?: typically w/ clay subsoil; may also have cemented alluvium	Yes/No: scattered ponding, extensive saturation	highly variable; minor acreage	3000 ac
Non-wetland soils:	Yolo, Spreckles, Goulding, Cole, Felta	loams on slopes and fans with no clay subsoil; incl. fine alluvial (sandy) soils; Yolo may be riparian	seasonal but intermittent, and typically less than full saturation	well drained to excessively well drained	typically not	No, but may support riparian vegetation	largely around periphery of valley & on major tributary fans	7000 ac

Source: Miller, et al, 1972 (SCS Soil Survey of Sonoma County)

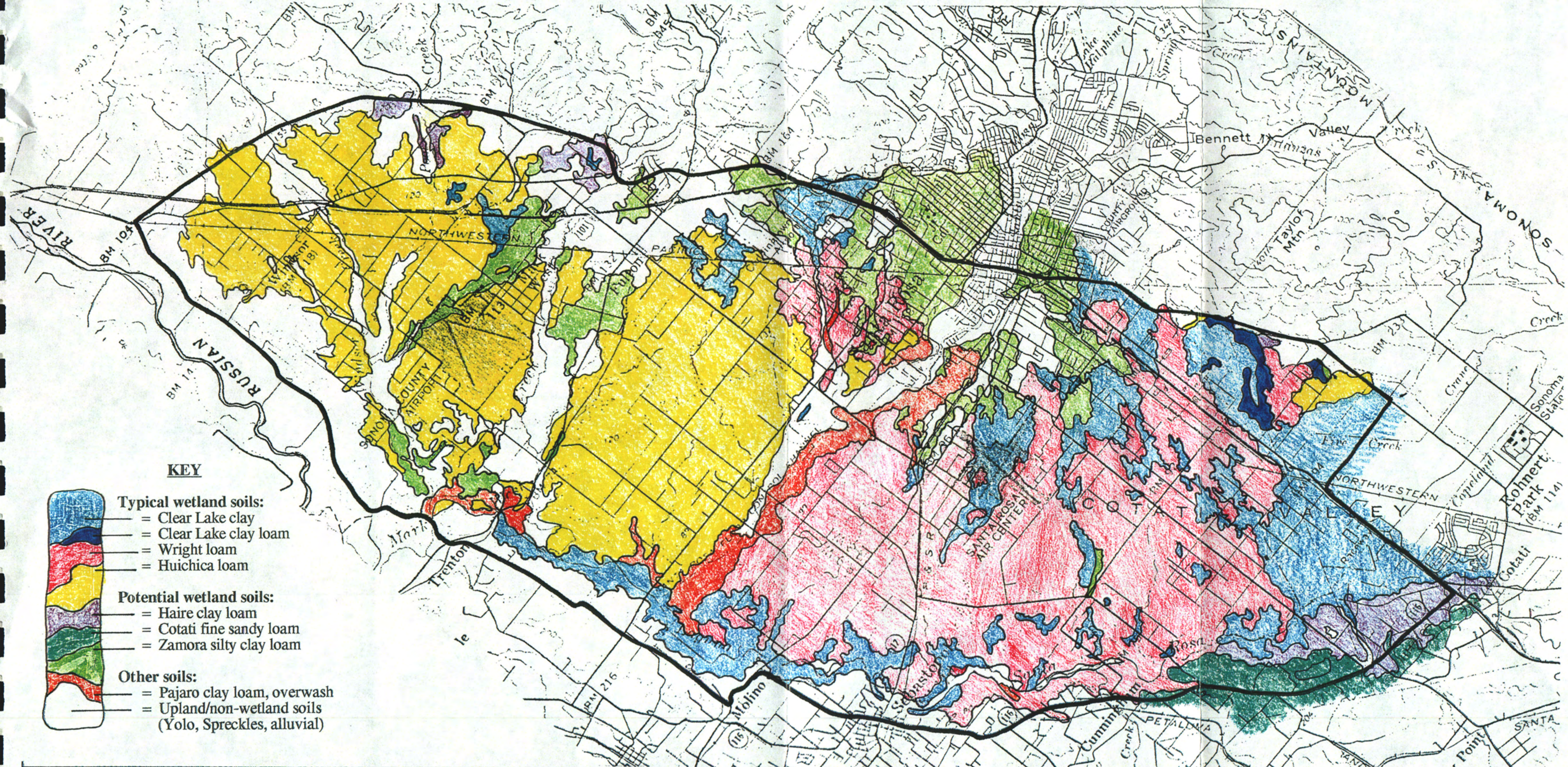

FIGURE 4
General Soils Map

NORTH	Source: Miller et al, 1972. SCS Soil Survey of Sonoma County	Sonoma County
	Adapted by: C. Patterson, 6/30/94	

SANTA ROSA PLAIN WETLAND BASELINE STUDY

The Plain's very low gradient and high clay soils work to retain runoff in low topographic areas (pools and swales), especially during intense storm events when the low natural rates of percolation cannot keep pace with the precipitation input (Miller et al., 1972) Hanes, 1991; Vandivere, 1993). With average or wetter winter weather, most basin and swale terrain attains full hydrological capacity and discharges surplus water toward the Laguna. If average precipitation is received in a widely distributed seasonal pattern, the lowest places retain water for the entire winter and early spring. The duration of ponding and saturation during dry periods depends on soil porosity, depth to and integrity of restrictive layer, and other factors.

The third hydrological phenomenon in the study area (and one which greatly influences the formation of vernal pools and wet swales) is the regionally typical formation of a perched water table in the silty clay loams that lie on top of the buried clay layer(s). On these soils (primarily Wright and Huichica), early season rainfall is able to slowly percolate into the surface loam, resulting in relatively little runoff and few areas of standing surface water. However, as the surface soil mantle becomes fully saturated, the formation of the perched water table occurs on top of the buried clay layer, eventually rising in the soil profile as more rain is added to the system. Once the water table has formed (generally achieved after about eight to 12 inches total season-to-date precipitation), subsequent rainfall input tends to reach the surface and fill the lower portions (vernal pools) of the swale systems, and spillage down-swale occurs. With average rainfall, full soil saturation and surface discharge from such water table systems occurs in about mid-December.

Precipitation Effects - Variation in annual precipitation ranges from low years of only 13-15 inches (1975-77, 1938, 1919) to over 50 inches (1982, 1940), with an average of about 30 inches at the Santa Rosa recording station (see Appendix A). In years of average or greater precipitation, the study area's pools and swales receive a surplus of water required for full inundation and saturation, and season-long duration. Hydrologically, wet and dry years are extremely different, with average or greater total precipitation resulting in considerable ponding and overall system outflow, while in dry years (depending on seasonal distribution) the total rainfall may lead to minimal (or no) ponding and little spillage from the swale systems to the Laguna. In drier years, such as the six ending with 1991/92, certain sites with other wetland characteristics may not qualify as "jurisdictional wetland" according to the Corps' hydrologic requirements. With no significant ponding, the shallower pools in dry years and most swales in all years can be dominated by non-native "Facultative" vegetation (i.e., having neutral wetland indicator status) as classified by the Service's list of wetland plants in California as part of the National Wetland Inventory (NWI, 1988).

Under wetter conditions (such as in the winter of 1992/93 or the first half of 1993/94), the study area's generalized soil mantle becomes fully saturated by approximately late December (C. Patterson, unpubl. field data), and a perched water table forms. On a Zamora soil in southwest Santa Rosa, Vandivere (1993) calculated that rainfall in excess of 11.2 inches (cumulative) will result in surface runoff, and Hanes' (1991) discussion of a site west of Santa Rosa identifies 16.6 inches as the potential evapotranspiration for the general Plain. Under both weather regimes (dry and wet), however, the network of collecting swales become saturated and generally remain so for a prolonged period, even with low amounts of rain, as runoff (surficial and subsurface) moves very slowly down-swale. Because of the wide fluctuations in annual precipitation (both total amount and temporal distribution), pools and swales in the study area exhibit a very wide range of growing conditions. Individual sites can vary from essentially dry all season in droughts, to full and spilling almost all season long, as well as every regime of depth and duration in between.

Vernal Pools and Swales - The majority of wetlands on the Santa Rosa Plain, and those most commonly associated with sensitive species, are seasonal in character. They result from poor drainage and restricted percolation, combined with low gradients, high clay soils, and rainfall in excess of that used in evapotranspiration. In general, the study area's lowest topographic positions receive almost immediate inflow from intense rainfall that cannot infiltrate, as well as subsequent inflow from saturated soils upslope once the landscape has become fully charged. As the rainy season progresses, the soils become fully saturated, pools form, and fill to the point where overflow spillage moves downslope. Later in the season and between storms, very slow subsurface lateral flow from the surrounding upland's water table (a perched aquifer) recharges the nearby swale bottoms and pools, extending the time that the water table occurs in the lower elevational areas. This slow subsurface drainage on top of the buried restrictive layer contributes inflow (recharge) to the pools themselves, extending their periods of ponding (C. Patterson, unpubl. field data, 1991 to 1994).

Because of the landscape's pervasive underlying clay, this phenomenon occurs not only in areas of lowest absolute elevations, but also in areas of lowest relative topographic positions. The result is a soil mantle that is influenced virtually throughout the study area by perched water tables, and a resulting mosaic of interdigitating wetland and upland that occurs regardless of absolute elevation, often varying across a given site. Pools and swales that exhibit saturated soil may occur only a few inches below a side slope with upland vegetation, and may also occur at elevations higher than nearby areas of upland. Depending on the depth to the clay layer and the local topography, such perched water tables can occur at even the highest elevations, with both wetland and upland conditions potentially occurring at all absolute elevations on a site.

Vernal pools in the study area include a range of sub-types, including shallow, intermittent pools and others that are larger, deeper, and more persistent. Many factors influence the water depth and duration characteristics of a given pool, and few sites experience the same conditions from year to year. Basins with large watersheds (more than a few acres) tend to fill sooner, with less cumulative rainfall, and persist longer (and are hence more stable), while perched flats and headwater depressions may require more precipitation to become inundated or saturated, and are generally more apt to dry out during dry periods between storms. Areas with thicker layers of loam on top of the denser clay also require more rainfall to become fully saturated and/or ponded. At the wetter end of the Plain's spectrum of seasonal wetland hydrology are the backwaters and floodplain lowlands along the immediate Laguna corridor. These areas become (and remain) ponded from major creek overflow and are influenced by the total runoff on all lands upslope in the drainage.

While a certain amount of cumulative precipitation (typically 8 to 15 inches) is necessary for pools to form on most soils with a surface loam, pool formation on dense clay, primarily the Clear Lake series, can occur soon after the first major rains of the season. Some soil wetting and crack closure must occur first, but these clays swell quickly when wetted and create effective surface barriers to infiltration. Subsoil water tables are generally not present in these soils, and without lateral recharge from the perched aquifers, these areas are often subject to rapid and frequent in-season drying. Clayey lands that have been under long-term or especially heavy livestock use can exhibit localized surface soil compaction to the extent that ponding occurs above a soil profile that is not saturated or even fully wetted (C. Patterson, D. Martel, unpubl. field data).

Creeks and Channels - Numerous small ephemeral creeks cross the Plain, all eventually joining the Laguna which flows north to the Russian River, just northwest of the study area. These creeks consist of eroded or incised channels ranging in width from a few feet to about 40 feet, typically with steep dirt banks and patchy riparian oak woodland of coast live oak, valley oak, bay, ash, walnut and, occasionally, willow. These creeks, while representing jurisdictional "waters of the U.S." as intermittent streambeds (bed and bank), do not provide habitat for the wetland species emphasized in this study and were not surveyed or characterized in detail. However, it is recognized that they do play a vital role in the overall drainage patterns and hydrology of the Plain. They may also provide habitat for other aquatic species of concern such as the California freshwater shrimp. With remnant pockets of riparian woodland and thicket, these features represent a wetland resource of considerable value, but with much different hydrology and more common vegetation than the study area's seasonal wetlands. Many of the Plain's streams have been converted into deeper, wider trapezoidal (flood control) channels, often without any significant woody vegetation.

The more well-defined creeks serve to hydrologically divide the Plain into separate drainage systems and hence naturally isolate many of the vernal pool and swale networks. These creeks also drain many of the swale and pool systems that occur on the Plain, providing a slightly deeper, more effective drainage route from the flatter portions of the landscape. Historically, it appears that some of the creeks actually aided in supplying the Plain's swales and vernal pools with water by serving as runoff routes for rainfall originating in the hills to the east. As major pulses of runoff moved westward across the Plain in these creeks, the higher flows overtopped the low creekbanks and spread across the Plain. In dry years, this probably did not occur. With uncontrolled runoff and such periodic overflow, the creeks may have aided in the formation and maintenance of the swale and pool topography by providing periodic scouring.

Through historic and recent development on the Plain, however, many of the creeks have been converted to deeper, more efficient flood control channels. These new channels facilitate more rapid and complete drainage from the Plain, as well as conveying eastside runoff through the study area with minimal (or no) bank overtopping. The overall effect of this channelization is not well-documented, but is likely to include dewatering of portions of the study area. Larger creeks also serve as migration routes for numerous aquatic species, including several non-native predators (e.g., crayfish and mosquito fish) of the native seasonal wetland fauna.

Historic Hydrological Alterations - The construction of major regional flood control channels, storm drains, and roadside ditches has reduced the occasional intense bursts of runoff that historically spread across the Plain, thus reducing the attendant scouring, and potentially affecting the natural dispersal and redistribution of wetland seeds and other propagules. The modern system of ditches and channels contributes incrementally to an overall dewatering of the Plain, both in the urban areas where primary flood control via large channels and buried drains, and also across the lower (western) parts of the Plain where such channels continue to convey runoff toward the Laguna without any appreciable bank overtopping.

While not necessarily draining surface swales or pools directly, such channels (in places) also cut down through the soil profile to well below the top of the underlying restrictive clay layers and facilitate drainage from the adjacent lands. This allows faster and more complete lateral movement of water out of the perched water table system and into the deeper creek channel. Lateral water movement is naturally very slow because of the fine textured soils and very low gradients. Flood channels and primary ditches do not necessarily drain the topsoil aquifer quickly or completely, but probably reduce to some degree the water table's extent and duration, and may also cause adjacent sites to dry out more rapidly in the spring.

Other hydrological alterations have occurred where historic cultivation or other land uses have reduced or eliminated the local topographic variation. Repeated discing and land leveling have evened out the landscape, and many orchard situations historically involved the creation of broad ridges on which trees were planted, and lower man-made drainage swales. Combined with extensive localized ditching, this too has a dewatering effect, shunting more rainfall away from potential topsoil percolation to sheet flow collection and offsite conveyance. Most of the Plain has been subject to at least some local efforts by farmers to facilitate drainage, and areas previously used for orchards and row crops have been graded to make them more usable.

2.1.4 Flora and Fauna

The natural vegetation of the Santa Rosa Plain includes primarily oak savanna, oak woodland, riparian forest and thicket, and valley grassland. The predominant cover was a mesic valley grassland of California oatgrass, purple needlegrass, blue wildrye, creeping wildrye, squirreltail, meadow barley, numerous annual and perennial herbs, wildflowers, and in the wetter places, California semaphore grass. Several oak species (valley, Oregon or Garry, coast live, blue, California black) formed open savannas and woodlands of moderate density. Creeks supported mixed riparian woodland and thicket vegetation, along with pockets of freshwater marsh, riparian herbs and scrub. Historic land use, however, has drastically altered both the vegetation and flora throughout the study area. Large areas have long since been cleared of trees and virtually all land has been affected to some degree by livestock grazing and non-native species invasions (e.g., *Lolium, Bromus, Avena, Hordeum, Brassica*).

The native flora is rich in grassland species associated with several different natural plant communities, ranging from dry-site needlegrass and annual wildflower communities, to meadow, wet meadow, and vernal pool. These communities support numerous common upland grasses and herbs (e.g., *Stipa, Elymus, Sitanion, Lupinus, Amsinckia, Ranunculus, Collinsia, Platystemon, Sidalcea, Wyethia, Calochortus*), meadow and swale plants (*Danthonia, Juncus, Sisyrinchium, Brodiaea, Orthocarpus*), and vernal pool species (e.g., *Downingia, Lasthenia, Plagiobothrys, Lilaea, Pleuropogon, Eleocharis, Eryngium*), including several regional endemics. Oaks are the dominant trees, and there are few shrub communities. Appendix C is a checklist with scientific and common names for plants the Santa Rosa Plain.

The entire valley has been grazed by livestock in the past, and much of it continues to be so managed. The native vegetation generally does not flourish under the current grazing regimes, and numerous well-adapted exotic weeds (including *Bromus, Hordeum, Brassica, Centaurea, Plantago, Picris, Raphanus, Lactuca, Convolvulus, Rumex*) and forage species (e.g., *Lolium, Avena, Trifolium, Poa annua, Festuca, Melilotus*) are widely established. Continued and intensified land use (e.g., vineyard, orchard, row crops, irrigated pasture, wastewater disposal, residential) has eliminated most of the native vegetation and favors the non-natives. However, there are pockets and scattered isolated features where natural soil and hydrological conditions persist and human and/or livestock disturbance has not been severe, and where the native flora survives. Wetland habitats in particular have more effectively weathered the effects of livestock, weeds, and other ecological disturbances.

Vernal pools and the deeper swales support most of the threatened and endangered plants on the Santa Rosa Plain. Many of the species found in these habitats are restricted to the temporary aquatic environment provided by the vernal pool habitat. Geographically, the vernal pool plant community is inherently uncommon because of the unusual combination of soils, climate, and hydrology its habitat requires. Vernal pool habitat (often with an unique local flora) is limited to portions of California, South Africa, Chile, and Australia (Thorne, 1981). The flora of Sonoma County's vernal pools is unique, containing a number of common species in addition to three regional endemics.

The long evolutionary history that culminated in the Santa Rosa Plain ecosystem was undoubtedly complex and involved the interactions between numerous upland and wetland species and communities. There is relatively little left, however, of the natural flora and vegetation, or the processes which formed them, and extensive fragmentation and displacement by non-natives have occurred, to the point where understanding all of the natural interrelationships between plants, animals, pollinators, herbivores, predators, and decomposers may not be possible in this region.

Under pre-settlement conditions, native wildlife played a much greater role in the ecological processes of the Santa Rosa Plain and its wetlands. Wildlife functioned as grazers, predators, and burrowers, but have been displaced and their ongoing influences (such as soil turning, seed scarification, pollination, and other food chain relationships) have diminished. Currently there is a new community of agricultural, introduced, accidental, and domestic animal species (including livestock, starlings, opossums, rats, dogs and cats, crayfish, mosquitofish, bullfrogs, etc.) that are competing with the natives. Current faunal influences include predation on native aquatic species (frogs, salamanders, invertebrates) by introduced crayfish, mosquito- and other freshwater fish, harassment of birds by dogs and cats, plus the continued disturbance of topsoil and vegetation by concentrated assemblages of agricultural animals.

2.1.5 Human Settlement

No research has been done for this report regarding the timing and degree of initial human settlement in the study area, but it should be recognized that settlement by man constitutes the greatest single factor affecting wetlands in the study area. The landscape here has been subject to numerous agricultural land uses and physical changes over at least the past 100 years. Early settlers brought livestock, introduced exotic vegetation, cut down trees, and began working the soil. Modern land use has involved a wide range of disruptive activities, ranging from intense land leveling, cultivation and irrigation, to complete development for urban uses. Continued use of the land has resulted in the conversion of native grasslands into non-native annual types, while large areas of oak woodland have been removed to facilitate all types of agriculture.

2.2 Habitat Types

2.2.1 General Conditions

The study area's pristine landscape contained a complex mosaic of grassland and oak savanna, extensively interspersed with meandering swales and vernal pools. That situation has been significantly modified, however, and it is apparent from historic air photos and remnant undisturbed parcels that oak woodland and savanna were much more extensive prior to human settlement. Waaland et al. (1990) estimate that over 90 percent of the oak woodland and savanna habitats have been converted to other uses and vegetation cover. Modern land uses have lowered the higher ground and filled in the lower areas (swales and pools), while ditches, roads, and checkerboard land use patterns interrupted the natural drainages and overall habitat continuity.

Upland areas (grasslands and oak communities) are much easier to farm or cultivate, and the non-wetland habitats have subsequently been altered the most, with tree removal occurring to clear the land for agriculture, and nearly complete conversion of the naturally occurring grasslands to non-native annuals and introduced forage species. The remaining wetland habitats, on the other hand, even though they have been the subject of extensive draining and filling activities, have retained significant pockets of remnant native vegetation. Since the topographic depressions are seasonally unusable for farming and ranching (because of their wetness) and still contain the hydrologic conditions that favor native wetland annuals, these habitats have suffered less intrusion by introduced species. Even these areas, however, are largely surrounded by disturbed habitats, and where they are less well-developed, are routinely cultivated, grazed, or otherwise affected by agricultural land uses during the drier part of the year. Heavily grazed and cropped (hay) lands with swale and pool habitats exhibit a combination of weedy wetland vegetation (e.g., *Rumex, Xanthium, Polypogon, Cyperus, Mentha,* etc.) in addition to the native wetland flora, with the deeper pools retaining more of the natural character than the shallower swales.

The region's broad swales in particular are highly vulnerable to the invasion by introduced grasses and the degrading effects of grazing and cultivation. Since swales are relatively dry (intermittently saturated versus ponded) and often poorly defined, the native flora is at a competitive disadvantage compared to the aggressive and highly adaptable non-native grasses and weeds that flourish in such habitats. Such species as Italian ryegrass, Mediterranean barley, curly dock, and annual bluegrass are well adapted to clayey soils and prolonged soil saturation, making them effective competitors with the native meadow flora of the swale habitats. In the larger and deeper basins (vernal pools), even dry years generally include some surface inundation. This is effective in drowning the non-native grasses and reducing competition for the native species. Still, even the more well-developed and stable wetlands are vulnerable to invasion by non-native wetland species such as dock, mint, umbrella sedge, rabbitfoot grass, cocklebur, lippia, and others.

A second factor that places the vegetation of the more subtle swale and shallower pool features at greater risk to invasion by exotics is that the relative dryness in these features allows them to be used, cultivated, grazed, and/or irrigated during a major part of most years and all year in some. These influences favor the non-native annual grasses and weeds over the native species. While repeated discing tends to reduce micro-relief, encourage exotics, and adversely affect natives, occasional situations where the opposite is true also exist. Even where the physical conditions have remained relatively undisturbed, natural swales are often dominated by dense, depauperate stands of *Juncus*, mint, *Eryngium*, and several non-natives (i.e., *Lolium, Hordeum, Rumex, Vulpia, Polypogon, Lythrum, Cyperus*).

2.2.2 Uplands

Prior to human settlement, oak woodland/savanna and grass communities dominated throughout the valley region, overlain with an intricate network of topographic drainage swales and pool complexes. However, most woodland has been cut and much of the native grassland in the study area has been converted to either a non-native annual type or cropland. Pockets and minor elements of the native grasslands still occur in the study area, but continued and intensified use of the land prevents any significant recovery of the native upland vegetation. The following are brief descriptions of the study area's non-wetland plant communities (* denotes an equivalent community to that described by Holland, 1986):

Non-native Annual Grassland* - This is the most common vegetation type in the study area and is composed of clay-tolerant introduced species such as Italian ryegrass, bromes, wild barley, vetches, wild oats, lupines, and tarweeds, plus numerous agricultural weeds (e.g., *Erodium, Raphanus, Brassica, Centaurea, Rumex, Lactuca, Picris*). It is highly variable in species composition, and occasionally blends with the more perennial types. A total of roughly 6,500 acres of this habitat was identified on the Plain by Waaland et al. (1990). Some annual grassland patches are relative large, especially in the southeastern part of the study area, and there are many smaller scattered parcels and vacant urban lots that consist of this type. Annual grassland is dominant over most undeveloped regional uplands, including vacant land, livestock pasture, and many hayfields.

Perennial Grasslands - Occasional sites where disturbance has been minimal still support pockets of native grassland types, including valley needlegrass grassland* (with *Stipa, Danthonia, Elymus*), valley wildrye grassland* (*Elymus triticoides*), and wildflower field* (including *Brodiaea, Lupinus, Collinsia, Sidalcea, Sisyrinchium, Wyethia, Ranunculus*, etc.). The more mesic upland situations in the study area are largely dominated by California oatgrass, while the wetter areas (swales) typically support oatgrass, meadow barley, semaphore grass, and seasonal wetland herbs.

Irrigated Pasture - There are approximately 4,500 acres of intensely managed pasture in the study area, most of it irrigated with reclaimed effluent and used for sheep and cattle grazing or cultivated for hay, silage, and/or green-chop. The dominant species include forage grasses (e.g., *Lolium, Festuca arundinacea, Poa annua*) and herbs (e.g., *Vicia, Trifolium, Melilotus*). This habitat mixes with irrigated oak woodland in the central part of the study area, but is most widespread north of Highway 12. The distribution of this habitat type is largely controlled by a network of pipelines which supply reclaimed water. Although a certain percentage of this type was once oak savanna or woodland, most of the current irrigated pasture occurs in areas that were historically probably native grassland. There is also considerable acreage of historic or even remaining seasonal wetland that is now used as irrigated pasture. The natural topographic and hydrologic conditions are in many cases still present, but in addition to either cropping or grazing, the out-of-season irrigation renders such areas unsuitable for most native species, wetland and/or upland.

While not causing any direct filling or disruption of the physical wetland habitats, summer irrigation represents a major threat to native plants and vernal pool endemics in the study area. One of the only natives to persist under intensely cultivated wet situations is western manna grass (*Glyceria occidentalis*). On the other hand, land which has been under such land use is likely to be highly suitable for habitat and natural plant community restoration since the fundamental physical habitat conditions have not been lost.

Oak Woodland - The denser oak woodland habitats typically have several structural layers (groundcover, shrubs, understory trees, mature canopy trees) and higher species richness than most of the other upland habitats in the study area. In the valley setting, the most common communities are valley oak woodland*, coast live oak woodland*, and black oak woodland*, with very minor scattered representation by blue oak woodland*, Oregon oak woodland*, and mixed north slope cismontane woodland* in the hills along the study area's western edge. Valley oaks in particular are naturally dominant and still relatively common, although they now occur largely as lone individuals and small isolated clusters. Only a few fragmented sites are still known to support this denser type of oak habitat, and even these examples have been generally overgrazed. Oaks still occur in open savannas on the larger rural parcels, and California black oak occurs in some abundance in protected pockets and riparian zones in the study area.

While the lack of native oak regeneration is currently a serious issue related to land uses, droughts, native browse pressures, and other factors, there are currently numerous sites in the study area with abundant oak regeneration, including valley and coast live oaks. Many such sites are abandoned fields or orchards that have recovered in the last 20 years. Virtually all grazed, disced, and intensively irrigated land, however, is devoid of such regeneration.

Oak Savanna - The more open wooded areas are referred to as savanna, and commonly support the same main species of trees, just in very low densities. These areas tend to occur on drier sites than the woodlands, however, and the most dominant trees are valley oak and blue oak. In terms of classification, they most closely resemble the open phases of valley oak woodland* and blue oak woodland*. Previous studies have identified approximately 1,300 acres of savanna habitat out of a 28,000 acre study area (Waaland et al., 1990). These remnants are scattered across the Plain in fragments of varying size, including several large tracts in the west-central part.

Natural savanna communities were probably some of the richest and most productive, supporting dense grasslands, upland and wetland, vernal pools, small creeks, and large mature valley oaks at widely spaced intervals. Essentially all of the grassland now present where oak savanna still exists is non-native, and most current land uses on these lands preclude oak regeneration. A few lowland pockets that have not been completely converted to agriculture and/or non-native grassland still support oak savanna with a relatively natural wildrye grassland* and stands of California oatgrass. Savanna habitats are valuable to wildlife, but only in relatively large tracts. While small, densely stocked woodlands can remain productive, and wetlands and grassland often persist in small fragments, savanna requires larger areas to be viable habitat for wildlife.

Irrigated Oak Savanna - Previous studies have identified about 1,500 acres of irrigated valley oak savanna on the Santa Rosa Plain, accounting for more than half of the total remaining oak savanna. Most of this acreage is located south of Highway 12 and between the Laguna de Santa Rosa and Santa Rosa city limits. Italian ryegrass and hare barley (*Hordeum leporinum*) are the most common grasses, and Italian thistle (*Carduus pycnocephalus*) frequently occurs in dense stands under the canopies of oaks. Studies by Waaland et al. (1990) on three farms near the Laguna indicate that mature oaks have been lost under intensive irrigation. Summer (wastewater) irrigation is generally not compatible with native oaks, and irrigation represents a primary concern regarding the future of the study area's remaining oaks.

Cropland - Approximately 1,000 acres of this habitat type are located in the study area. Essentially all of it occurs north of Occidental Road in areas of the Laguna and Santa Rosa Creek floodplains. Most of the cropland is composed of corn grown for silage. The better alluvial soils along the Santa Rosa Creek floodplain support row crops grown for commercial produce. Much of the Laguna floodplain cropland is flooded into early spring, reducing the effective growing season. Because the entire land surface is devoted to the production of an annual crop, there is continual and complete disturbance which maintains a uniform appearance and homogeneous species composition.

Orchards and Vineyards - This habitat type accounts for 3,800 acres, or 14 percent of the study area. Most of it is distributed in the northern portion, composed predominantly of vineyards. Grape vines are intensively managed to remain on trellises no more than five feet in height. Vines are normally intertwined in the rows, but remain open between rows. The grape is deciduous, reaching fruition in the fall, after which leaves drop. Between rows, grasses, herbs, and weeds may be allowed to grow, especially in the winter when the vines are dormant. In the spring and throughout the growing season the grasses and herbs are treated with herbicides or disced to prevent growth. Minor amounts of walnut orchard are also present; those in the south portion of the study area appearing to be abandoned. Some pear orchards are present in the northern portion. The fruit and nut trees are deciduous and range in height from 15-30 feet.

Urban - This land use type accounts for 7,000 acres, or about 25 percent of the study area. Included in this category are rural residences, subdivisions, ranchettes or businesses clustered at densities approximating one unit per five acres or less. Also included in the urban habitat are city parks and golf courses. The structure of urban vegetation varies, but is almost exclusively composed of non-native species and occurs in close proximity to homes and roads. Tree groves are common in golf courses, and shade trees and lawn are probably the most common vegetation features in the residential settings.

Occasional undeveloped parcels as large as 25 acres occur in the urban category, but these are typically surrounded by moderate and high density residential use. These urban islands of predominantly volunteer vegetation typically include annual grassland, scattered individual oaks, and/or occasional remnant pockets of seasonal wetland and vernal pools. While such habitat islands are generally less valuable for wildlife as their acreage diminishes and the degree of encroachment increases, they can still represent suitable habitat for any of several sensitive species (primarily plants and invertebrates). Further, while a great degree of degradation has already occurred on most vacant urban lots, wetland conditions are known to remain in places, with some still supporting sensitive species. Even where somewhat larger parcels may remain undeveloped within the urban area, a general loss of habitat value results from increased physical disturbance, increased predation from domestic pets, and competition from introduced grasses, weeds, and exotic animals that are better adapted to urban influences.

Somewhat larger and less degraded parcels occur along the urban fringe, combining the higher habitat values of less developed land with the typical ongoing disturbances of the urban land uses nearby. Ditching and draining are not as well developed as in the fully urbanized areas, and agriculture is often limited to personal use (e.g., a few horses or a garden), or may be abandoned altogether. Sensitive wetland resources still can occur on such lands, but because of the proximity to urban use, are often threatened by the encroaching influences and the pressure to expand the urban environment.

2.2.3 Wetlands

The study area contains a wide range of wetlands, from the riparian woodlands and thickets, flooded backwaters, and perennial wetlands along the major creeks and the Laguna, to the saturated flats, vernal pools, and shallow swales in the headwaters that dry by late May. Most of the area's wetlands are seasonal in character, becoming saturated or inundated during the winter, only to dry relatively quickly once the rainy season is over. Figure 5 shows a generalized cross section of the Plain's seasonal wetlands. Interspersed throughout the region are agriculturally influenced (and unintentionally created) wetlands such as flooded fields, man-made swales and ditches, and relatively flat cultivated ground that can become and remain saturated long enough to qualify as jurisdictional wetland (yet remain unponded).

There are several different definitions of wetland used in regulatory and planning processes, and the Santa Rosa Plain contains numerous habitat types that qualify. For purposes of this report, wetlands are used in accordance with the technical definition of "jurisdictional wetlands" subject to regulation by the Corps under the CWA. These are vegetated features that exhibit evidence of (1) hydric soil, (2) a predominance of hydrophytic vegetation, and (3) wetland hydrology (prolonged saturation or inundation). Vernal pools and swales are included in this definition and activities in them are regulated. Land that is hydrologically altered and used to produce an annually harvested crop may be fully saturated and exempt from Corps jurisdiction as Prior Converted Cropland (PCC) or may be jurisdictional as Farmed Wetlands if inundated. These are two habitat categories that occur on the Plain which are recognized and treated differently than unmanaged isolated wetlands under the CWA. Other potentially jurisdictional habitats (but not necessarily technical "wetlands") on the Plain include, intermittent and perennial streams, abandoned ditches and ponds, and flooded fields. The following are brief descriptions of the most prominant or important wetland types in the study area:

Vernal Pools and Swales - Of greatest concern and importance with respect to the study area's endangered species are seasonally wet swales and vernal pools, especially those that have not been drastically altered or degraded. Shallow basins and sheet flow drainages typically become seasonally saturated and/or inundated for prolonged periods in the winter and spring. They include a range of subtypes, from simple surface depressions and very shallow, intermittent vernal pools on dense clay soils, to deep meandering swale/pool networks that are fed by larger upslope watersheds. In general, the Plain supports shallow, intermittent pools and broad swales in the headwaters (which fill and function largely with simple direct rainfall), with deeper and more convoluted systems of pools and swales farther downslope to the west (where larger upslope watersheds tend to foster more stable hydrological conditions).

Swales can be narrow (less than five feet wide) or up to 50 feet or more wide. They are characterized by more-or-less complete surface drainage (i.e., no standing water) after storm runoff stabilizes. Swales do not have defined bed or bank characteristics, and defining the outer boundary of most swales is difficult. Physically, a swale consists of the lower topographic portion of a broad concave drainage feature, typically including the area below the side slopes' points of inflection. Swales can consist of wetland (with prolonged soil saturation to the surface) or upland, seasonally waterlogged or relatively well-drained depending on soil texture, underlying horizons, and slope. Swales provide habitat for many native vernal pool and meadow species, as well as conditions for several native grasses. Swales are not specifically described as a plant community by Holland (1986), but locally, these habitats most closely resemble a combination of freshwater seep* and a low elevation form of montane meadow*. Other terms that could be used to describe these habitats include low elevation meadows, or mesic valley grassland.

Vernal pools are the topographic low areas, occurring either alone or within larger swale networks, which under average weather patterns become seasonally inundated for prolonged periods after storms. Such inundation is sufficient to favor specially-adapted wetland vegetation, with the surrounding grassland and swale communities (predominantly grasses) yielding to the unique pool assemblages dominated by annual herbs and wildflowers. Such seasonal pools in the study area include natural and man-made basins, and range from a few square feet to more than one acre in size. They support both native and naturalized vegetation, and vary from being intermittently inundated one or two inches for a few weeks at a time, to more than two feet deep and persisting in excess of 120 days. Several different habitat zones suitable for different plant species and assemblages occur in natural pools of this region, responding generally (and over time) to water depth and/or duration. The study area's vernal pools do not fit any of Holland's (1986) categories, but most closely resemble the northern claypan vernal pool*, and occasionally exhibit qualities of freshwater seep* and vernal marsh*. The Plain's vernal pools result less from cemented alluvium and/or deposited clay lenses as described by Holland, and more in response to the region's pervaisve underlying clay base.

Pools that contain, on average, roughly several inches up to about 12 inches of water foster a rich pool flora of native annuals (e.g., *Lasthenia, Downingia, Plagiobothrys, Gratiola, Blennosperma, Eryngium, Lilaea, Callitriche, Pilularia, Navarretia, Mimulus, Pogogyne, Juncus, Orthocarpus, Trifolium, Pleuropogon,* and others) while deeper pools tend to be sparser and contain only a few aquatic species (primarily *Lilaea, Callitriche, Eryngium, Pleuropogon, Glyceria*). Infrequently, such aquatic plants as elodea (*Elodea*) and *Zannichellia* are found in the more persistent pools.

Shallower pools and some swales are also excellent habitat for most pool species, but are vulnerable to recurring drought and non-native grass invasion. Dry years favor the exotics in such shallow basins, swales, and perched flats, resulting in mixtures of non-native annual grasses plus scattered small colonies of native wildflowers. In dry years, the natives may not be evident (shaded and outcompeted by the exotics), while in wetter years, elevated water levels and longer hydroperiods drown the grasses. Wet years favor the native species which are able to grow with less competition and are able to produce better seed crops. Over the long term, some of these subtle depressional features are able to maintain small native plant assemblages compared to immediately adjacent uplands where non-native grassland invasion has been more complete. Pools that are heavily grazed tend to show reduced dominance by native annuals, and an increase in exotics (e.g., *Rumex, Xanthium, Polypogon, Polygonum*) and perennials (including *Juncus, Lippia,* and *Mentha*).

Because of the region's poorly drained soils and ample rainfall, many isolated vernal pools in this region fill from direct rainfall alone. In dry years, these features are subject to non-native species invasion and potential native seed bank depletion. Many less well-developed wetlands do not represent significant aquatic habitats and, therefore, do not constitute habitat for fairy shrimp or tiger salamanders. However, several native meadow plants (e.g., *Deschampsia danthonioides, Hordeum brachyantherum, Orthocarpus faucibarbatus, Calochortus uniflorus, Brodiaea elegans, B. peduncularis, B. hyacinthina*) are well-adapted to pool edges, broad swales, and other shallow, intermittent, or non-ponded wet soil conditions. Two of the Plain's three federally listed species

(Burke's goldfields and Baker's blennosperma) are also well adapted to such pool edge conditions. Seasonal pools that are bigger, have a greater depth, and/or have a larger watershed are likely to exhibit more extensive or persistent inundation, and provide a more secure habitat for the native flora and fauna. Analysis of three relatively undisturbed sites in the study area (Waaland et al., 1990) showed the majority of the pools to be one-half acre or less in size. The proportion of these lands occupied by vernal pools was an average of 22 percent, up to as much as 26 percent. Scattered pools larger than one acre are present, however (C. Patterson, unpubl. field data), and some portions of the central Plain appear from air photos to approach 50 percent aerial coverage by pools and wet swales under wet conditions (e.g., March 1991). Still, areas of unaltered natural topography usually do not exceed 20 to 30 percent wetland, except along portions of the immediate Laguna where peak winter backwaters can flood extensive land areas. Interestingly, managed lands that have been excavated, leveled, or which accidentally have surface drainage impeded can reach much higher proportions of wetland (50 to 80 percent).

Valley Foothill Riparian - This generalized woody riparian community occurred historically along most of the larger ephemeral creeks and along all perennial waterways. The dominant cover is a dense blend of oaks (valley, coast live, California black), bay, willows, Oregon ash, California walnut, and infrequent cottonwood, plus understory tangles of introduced and native blackberry, poison oak, wild rose, coyote brush, occasional wild grape and honeysuckle, and numerous herbs (*Artemisia douglasiana, Solidago, Aster chilensis*, etc.) and grasses (e.g., *Elymus triticoides, Danthonia*). The pre-settlement waterways supported a range of woody riparian types, including a predominance of central coast live oak riparian forest*, ("Great Valley") valley oak riparian forest*, ("Great Valley") mixed riparian forest*, and central coast riparian scrub*, plus minor representation by central coast arroyo willow riparian forest*, ("Great Valley") cottonwood riparian forest*, and mule fat scrub*. Along the more ephemeral streams, valley oak woodland and black oak woodland* form more open and less strictly riparian communities.

The present distribution of riparian forest and woodland in the study area is concentrated into two main areas: north of Occidental Road and the Sebastopol forest on the Laguna de Santa Rosa. The total acreage estimated for the Laguna is 450 acres (Waaland et al., 1990). Just as most of the study area's oak savanna has been cut or converted to other types, major blocks of historic riparian forest and woodland have been removed by flood control and channelization projects, agricultural encroachment into the creek corridors, and other land use activities. In large tracts, this community provides suitable habitat for numerous common and sensitive bird species, but only a few scattered and relatively small areas of this habitat type still exist on the Plain. Examination of the maps in Attachment 2 reveals that extensive sections of the Plain's creek corridors have been severely encroached, with an attendant removal of woody vegetation. Except for places near the Laguna, almost all of the remaining woody riparian communities on the Plain consist of very narrow linear (and largely discontinuous) strips of trees left along the immediate waterway's banks.

Freshwater Emergent Wetland - This general habitat type includes coastal and valley freshwater marsh* and vernal marsh*. The dominant plants are native grass-like species (primarily *Typha, Scirpus, Juncus, Carex*), but also include numerous other emergent and aquatic species such as *Alisma, Rorippa, Machaerocarpus, Nasturtium, Jussiaea, Oenanthe, Ludwigia, Myriophyllum, Polygonum, Potamogeton, Potentilla anserina, Lemna, and Wolffia*. Previous studies identified roughly 1,900 acres of freshwater emergent wetland. Of this total, only 150 acres are perennially wet marshes (most occurring along the floodplain of the Laguna), the remainder being semi-persistent seasonal wetlands in areas of Clear Lake clay. This habitat is typified by relatively deep water and/or prolonged (even year-round) wetness, and does not constitute suitable habitat for most sensitive species. Further, the species composition of these marshes tends to be simple and common, and summer irrigation is not necessarily detrimental. Many such habitats in this region have been heavily disturbed and ecologically degraded by excessive nutrient (livestock manure) input and the resultant high biological oxygen demand. Freshwater marsh is typically the type of wetland created by either excessive irrigation and subsequent runoff, as well as through intentional wetland creation involving wastewater disposal and treatment. This habitat type is very productive and has extremely high value for numerous wildlife species, but does not represent suitable habitat for most vernal pool species.

Plate 3. Late season ponding in a deep natural swale, northwest Santa Rosa, 1989. The middle supports *Eleocharis, Pleuropogon,* and *Eryngium,* while the edges are dominated by *Orthocarpus faucibarbatus, Blennosperma bakeri, Lolium, Hordeum,* and *Rumex.*

Plate 4. Natural (non-ponded) swale at the peak of spring flowering, just west of Santa Rosa, 1989. Moving outward from the bottom of the swale, the dominant plants include *Limnanthes douglasii* var. *nivea* (white), *Blennosperma bakeri* and *Orthocarpus faucibarbatus* (yellow), and *Trifolium variegatum* and *Collinsia* (purple) blending into upland.

Seeps and Springs - Seeps and springs are largely absent from the study area since these features typically occur where groundwater reaches the surface on a slope, and such slopes are generally excluded from the study area (which is essentially defined as the valley plain below the surrounding foothills). There are numerous such seeps and springs, as well as perennial marshes and well developed riparian corridors, however, in the hilly region just west of the study area boundary, roughly between Cunningham and southern Sebastopol, north to Graton and Forestville. Several of the historic marshes in this region, such as Cunningham, Pitkin, and those on Blucher and Atascadero creeks are at least partially spring fed, and several have historically contained (and a few continue to support) several sensitive plants. In particular, Sebastopol meadowfoam is known from numerous historic locations along the western study area boundary. At least one property in the study area does contain an unusual seep-supported population of Sebastopol meadowfoam, immediately west of the Laguna at (north of) Llano Road.

2.3 Species of Concern

Numerous plant and animal species throughout the state and region have been depleted so greatly through loss of habitat that various local, state, and federal agencies and private organizations have recognized them as either candidates for protection or have listed them as rare, threatened, or endangered. On the Santa Rosa Plain, three plants have become so recognized and protected at the federal level under the Endangered Species Act, and one amphibian, the California tiger salamander has been proposed for listing. The listed species are afforded legal status and are to be fully considered (subject to a Section 7 consultation with the Service) and protected when the Corps permits an action under the Clean Water Act. These and other species are also recognized by state policies, CEQA, regional CNPS guidelines, City and County planning policies. For the purposes of this study, plants on any of the current or recent CNPS lists (1A through 4) were considered as potentially sensitive. While many native vernal pool plants are still regarded as common and are not specifically recognized or listed, as part of a greatly depleted plant community virtually all native pool taxa have declined and warrant some consideration. CNPS List 4 plants alone are not necessarily enough of a legal constraint to prevent or significantly alter a proposed project or change in land use, but multiple occurrences and the combination with jurisdictional wetlands can often require mitigation. In general, the occurrence together of several native pool species indicates the presence of potential vernal pool habitat and the possibility of sensitive species.

Detailed seasonal surveys for sensitive species are now routinely required in the study area, with two separate years of negative findings often required to conclusively demonstrate absence. Spring is when the species of greatest concern are evident and identifiable, typically April and May. However, annual weather patterns and individual species' characteristics dictate that in order to cover all species of potential concern, a full season of investigation should begin by late February and, in most years, continue until at least early June.

2.3.1 Plant Species of Primary Concern

There are more than 50 sensitive plant taxa that are known or expected within the region immediately surrounding the study area; approximately the overall area shown on Figure 2. There are three plants believed to be extinct in the region: Pitkin Marsh paintbrush (*Castilleja uliginosa*), showy Indian clover (*Trifolium amoenum*), and Petaluma popcornflower (*Plagiobothrys mollis* var. *vestitus*). There are about 30 taxa that are of high concern (CNPS List 1b) and are potentially protected under CEQA, and an additional dozen or more which are of lower CNPS listing (lists 2, 3, or 4). About 10 species are documented as still occurring in the study area's wetlands. Table 2 presents the master list of regionally possible rare plants, and Table 3 summarizes the sensitive species known to occur here.

While there are a number of sensitive species that have declined in this region and others that are dependent on dwindling habitats, there are three plants that are listed and protected under both state and federal laws. These are Sebastopol meadowfoam (*Limnanthes vinculans*), Burke's goldfields (*Lasthenia burkei*), and Baker's blennosperma (*Blennosperma bakeri*). All three are small winter/spring annuals dependent upon seasonal wetlands. All are largely endemic to the Plain.

Table 2. Sensitive plants potentially in the greater Santa Rosa r gion

PLANT TAXON	COMMON NAME	LIST	R-E-D	FWS	CDFG	HABITAT
SPECIES OF PRIMARY CONCERN:						
Castilleja uliginosa	Pitkin Marsh paintbrush	1a	PE 1987	C2	E	marshes, wet meadow; Pitkin Marsh
Plagiobothrys mollis var. vestitus	Petaluma popcorn flower	1a	PE 1888	C2	-	valley flats, vernal pools ?
Alopecurus aequalis var. sonomensis	Sonoma alopecurus	1b	3-3-3	C2	-	low wet places, marsh, riparian scrub
Arctostaphylos bakeri ssp. bakeri	Baker's manzanita	1b	3-3-3	C3c	R	dry serp., near Occidental
Arctostaphylos canescens var. sonomensis	Sonoma manzanita	1b	2-2-3	-	-	chaparral
Arct staphylos densiflora	Vine Hill or Sonoma manzanita	1b	3-3-3	C2	E	dry slopes, chaparral, roadside
Arctostaphylos stanfordiana ssp. decumbens	Rincon Ridge manzanita	1b	3-3-3	-	-	chaparral, edge of woodland
Astragalus clarianus	Clara Hunt's milkvetch	1b	3-3-3	C1	T	grassy hillsides, cismontane woodland
Blennosperma bakeri	Baker's blennosperma	1b	2-3-3	E	E	low wet places; valley grassland, vernal pools
Campanula californica	swamp harebell	1b	1-2-3	C2	-	freshwater marshes, bogs, closed cone pine, wet meadow,
Carex albida	white sedge	1b	3-3-3	C1	E	open marshy places; Pitkin Marsh
Ceanothus confusus	Rincon Ridge ceanothus	1b	3-3-3	C2	-	foothill woodland, chaparral
Ceanothus divergens	Calistoga ceanothus	1b	3-2-3	C2	-	chaparral, woodland; serpentine
Ceanothus foliosus var. vineatus	Vine Hill ceanothus	1b	3-3-3	C2	-	chaparral
Ceanothus sonomensis	Sonoma ceanothus	1b	3-2-3	C2	-	chaparral, Hood Mountain region
Clarkia imbricata	Vine Hill clarkia	1b	3-3-3	C1	E	chaparral near Pitkin Marsh
Cordylanthus tenuis ssp. capillaris	Pennel's bird's-beak	1b	3-2-3	PE	R	dry open places

Table 2. Sensitive plants potentially in the gr ater Santa Rosa region

PLANT TAXON	COMMON NAME	LIST	R-E-D	FWS	CDFG	HABITAT
Delphinium bakeri	Baker's larkspur	1b	3-3-3	C1	R	low brush and fencerows; coast'l prairie
Delphinium luteum	yellow larkspur	1b	3-3-3	C1	R	sea bluffs, coastal scrub
Fritillaria liliacea	fragrant fritillary	1b	1-2-3	C2	-	heavy adobe soils, coastal grassland and scrub
Gratiola heterosepala	Bogg's Lake hedge-hyssop	1b	1-2-2	C3c	E	vernal pools, shallow marshy ground
Lasthenia burkei	Burke's goldfields	1b	3-3-3	E	E	vernal pools, wet swales
Legenere limosa	legenere	1b	2-3-3	C2	-	vernal pools; valley grassland
Lilium pardalinum ssp. pitkinense	Pitkin Marsh lily	1b	3-3-3	C1	E	wet marshy ground, Pitkin Marsh
Limnanthes vinculans	Cunningham Marsh or Sebastopol meadowfoam	1b	2-3-3	E	E	vernal pools, wet meadows
Navarr tia leucocephala ssp. bakeri	Baker's navarretia	1b	2-2-3	-	-	vernal pools, wet swales, mesic grassland?
Navarretia leucocephala ssp. plieantha	many- flowered navarretia	1b	3-2-3	C1	E	edges of vernal pools, meadows
Penstemon newberryi var. sonomensis	Sonoma beard tongue	1b	3-1-3	-	-	rocky chaparral
Pleuropogon hooverianus	Hoover's semaphore grass	1b	3-2-3	C2	R	meadows, coastal decid. forest, wet places
Rhynchospora californica	California beaked rush	1b	3-3-3	C2	-	bogs, swamps, freshwater marsh
Sidalcea oregana ssp. valida	Kenwood Marsh checker mallow	1b	3-3-3	C1	E	freshwater marsh
Trifolium amoenum	showy Indian clover	1b	3-3-3	C2*	-	low rich fields, swales; serpentine
SPECIES OF SECONDARY CONCERN:						
Carex californica	California sedge	2	3-1-1	-	-	coastal flats and prairie
Downingia pusilla	dwarf downingia	2	1-2-1	C3c	-	vernal pools; valley grassland

Table 2. Sensitive plants potentially in the greater Santa Rosa region

PLANT TAXON	COMMON NAME	LIST	R-E-D	FWS	CDFG	HABITAT
Rhynchospora globularis var. globularis	round headed beaked rush	2	3-3-1	-	-	bogs, freshwater marsh
Hemizonia congesta ssp. leucocephala	hayfield tarplant	3	?-?-3	-	-	coastal scrub, prairie, grassland
Pogogyne douglasii ssp. parviflora	Douglas' pogogyne	3	1-2-3	C3c	-	vernal pools, low seas. wet places
Astragalus breweri	Brewer's milkvetch	4	1-2-3	-	-	chaparral, woodland, grassland
Elymus californica (Hystrix c.)	California bottlebrush grass	4	1-1-3	C3c	-	coastal, shaded woods and forest
Perideridia gairdneri ssp. gairdneri	Gairdner's yampah	4	1-2-3	C2	-	moist places, marshes, woodland
Ranunculus lobbii	Lobb's aquatic buttercup	4	1-2-3	-	-	shallow vernal ponds & pools
Rhynchospora alba	white beaked rush	4	1-1-1	-	-	bogs, freshwater marsh
Ribes victoris	Victor's gooseberry	4	1-1-3	-	-	broadleaved up. forest, chaparral
Cuscuta howelliana	Bogg's Lake dodder		dropped	-	-	vernal pools
Hemizonia multicaulis ssp. vernalis	Tiburon tarplant		dropped	-	-	coastal scrub prairie; serpentine
Potentilla hickmanii var. uliginosa	Cunningham Marsh cinquefoil		dropped	-	-	freshwater marsh
Quercus lobata	valley oak		dropped	-	-	foot. & valley woodland, riparian
Ribes divaricatum var. publiflorum	straggly gooseberry		dropped	-	-	broadleaved up. forest, No. Coast forest
Trifolium grayi	Gray's clover		dropped	-	-	meadows, mesic grassland

LEGEND FOR TABLE 2

Plant Taxon: as listed by Skinner, M.W., and B. M. Pavlik, Ed.s (1994).

List: Refers to the list number on which the plant is included in Skinner and Pavlik, Ed.s (1994): California Native Plant Society's sensitive plant inventory. **1a**: Plants presumed extinct, **1b**: Plants rare or endangered in California and elsewhere, **2**: Plants rare or endangered in California, but more common elsewhere, **3**: Plants about which we need more information, and **4:** Plants of limited distribution [a watch list]. Appendix 1: plants considered, but not included.

R-E-D: rarity (R), endangerment (E), and distribution (D) code from Skinner, M.W., Ed. (1994) :

Rarity :

1 = Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction or extirpation is low at this time.
2 = Occurrence confined to several or one extended population(s).
3 = Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom seen.
PE = Presumed extinct in California (with date last seen)

Endangerment :

1 = Not endangered.
2 = Endangered in a portion of its range.
3 = Endangered throughout its range.

Distribution :

1 = More or less widespread outside California.
2 = Rare outside California.
3 = Endemic to California.

FWS: C1 = A candidate taxon, Category 1: information sufficient for federal listing by FWS (1985). C2 = Also a candidate, Category 2: information insufficient for formal proposal for listing. C3c = Previously considered, but currently considered to be too common for listing. * = presumed extinct.

CDFG: E = Endangered, R = Rare, T = Threatened; as designated by CDFG (1992).

Habitat, Elevation, Flowering Period: As reported in Munz and Keck (1959), Munz (1968), Skinner, M.W., Ed. (1994), Hickman, J.C., Ed. 1993, and/or Abrams and Ferris (1923 - 1951).

Table 3. Summary of sensitive plants known or historically reported on the Santa Rosa Plain

Plant Species	Status	Habitat	General Distribution	No. Hist. Sites in Study Area	No. of Sites Extir-pated	Sites Severely Degraded	No. of Sites Preserved	Acres Preserved	Rough Population Estimat	High Quality/ Priority Sites in Study Area	Sites Known Outside Study Area
SPECIES OF PRIMARY CONCERN:											
Blennosperma bakeri	Fed: E Calif: E CNPS: 1b	low wet places; valley grassland, vernal pools	southern Santa Rosa Plain; west to laguna; north to Fulton	5 3	9 +	1 2 +	6 + ?	~ 120 (+150? in ease.?)	900,000 +	26B10, 11, 20? 26?, 27?, 30, 32, 34, 35, 37, 40, 58; 26F06	~ 4
Lasthenia burkei	Fed: E Calif: E CNPS: 1b	vernal pools, wet swales	Windsor to Laguna; south to SW Santa Rosa;	8 5	2 0 +	1 8 +	1 5	~ 65	600,000 - 800,000	20C01, 7, 8; 20F05, 7, 8; 26B22, 33, 38, 40, 43, 44, 51	~ 4
Limnanthes vinculans	Fed: E Calif: E CNPS: 1b	vernal pools, wet meadows	Cotati to Laguna; north to Hall road	4 9	9 +	5 +	8 + ?	~ 170 (+ ease-ments ?)	700,000 + +	26D03, 4, 6; 26F01, 2, 4, 6, 12?, 17, 23, 26? 34; 32B01	~ 6
Navarretia leucocephala ssp. bakeri	CNPS: 1b	vernal pools, wet swales, mesic grassland?	unknown; scattered throughout? known at least in Windsor, western Santa Rosa	1 0 +	2 + ?		1+? (Alton Ln)	2 +	< 10,000 ?		yes
Navarretia leucocephala ssp. plieantha	Fed: C1 Calif: E CNPS: 1b	edges of vernal pools, meadows	only known from Sanders Road area, between Fulton & Windsor	2	?		0	0 ?	< 500 ?	20F 07, 08	yes
Pleuropogon hooverianus	Fed: C2 Calif: R CNPS: 1b	meadows, coastal decid. forest, wet places	not confirmed in study area; hist. report possibly erroneous	0 ?	?		0	0	0 ?		yes
Trifolium amoenum	Fed: C2 Calif: - CNPS: 1b	low rich fields, swales; serpentine	historically reported from "Santa Rosa"; no known sites	1 +	1 + ?		0	0	0 ?		yes (1)
SPECIES OF SECONDARY CONCERN:											
Downingia pusilla	CNPS: 2	vernal pools; valley grassland	scattered throughout	1 0 +	2 + +		3 + ?	~ 50 ?	50,000 - 200,000 ?		y s ++

Source: Patterson, Guggolz, and Waaland (Attachment 1), 1994

Table 3. Summary of sensitive plants known or historically reported on the Santa Rosa Plain

Plant Species	Status	Habitat	General Distribution	No. Hist. Sites in Study Area	No. of Sites Extir-pated	Sites Severely Degraded	No. of Sites Preserved	Acres Preserved	Rough Population Estimate	High Quality/ Priority Sites in Study Area	Sites Known Outside Study Area
Hemizonia congesta ssp. leucocephala	CNPS: 3	coastal scrub, prairie, grassland	scattered throughout	4 +	2 + ?		0 ?	?	?		yes
Pogogyne douglasii ssp. parviflora	CNPS: 3	vernal pools, low seas. wet places	scattered throughout	2 6	3 + +		7	100 +?	?		yes +
Perideridia gairdneri ssp. gairdneri	FED: C2 CNPS: 4	moist places, marshes, woodland	only two confirmed sites; Windsor and Todd Road	2 ?	?		1	75 ?	< 500 ?		yes +
Ranunculus lobbii	CNPS: 4	shallow vernal ponds & pools	scattered throughout	4 9 +	5 +		1 0	100 +?	?		y s +
Cuscuta howelliana	None	vernal pools	historically in Windsor	1 +	1 + ?		0		?		y s +
Hemizonia multicaulis ssp. vernalis (no longer valid)	None	coastal scrub prairie; serpentine	southern Santa Rosa Plain	1 +	?		?		?		yes +
Quercus lobata	None	foot. & valley woodland, riparian	scattered throughout	2 0 + +	?		5 +	?	?		yes +++
Trifolium barbigerum var. andrewsii (= T. grayi)	None	meadows, mesic grassland	general Windsor area	1 0 +	?		?		?		yes +

Source: Patterson, Guggolz, and Waaland (Attachment 1), 1994

Figures 6, 7, and 8 show the known locations and general distributions of these three primary species of concern in and around the study area. Additional descriptions of these species are presented in Appendix B, and site locations and rough population data are included in Attachment 1 (summary chart). Most of the plants on CNPS Lists 1a and 1b are regarded as rare, and generally require planning consideration under CEQA. Wetland fill actions that would affect any of the three federally listed species also requires full review and permitting by the Corps and "Section 7" consultation with the Service. Projects that will result in unavoidable impacts to these species require special permitting conditions and mitigation, including habitat value replacement, detailed monitoring, and attainment of specific success criteria.

2.3.2 Plant Species of Secondary Concern

There are more than 40 plants of secondary concern known or expected in the study area, ranging from several on CNPS' List 1b, to native oaks and riparian trees which may be protected locally or under CEQA, but are not necessarily on formal lists. Some, such as Lobb's aquatic buttercup (*Ranunculus lobbii*), are restricted to vernal pools, but are relatively well distributed and can be locally abundant. Others, including Gairdner's yampah (*Perideridia gairdneri* ssp. *gairdneri*) and many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha*) are quite scarce in the study area, while Douglas' pogogyne (*Pogogyne douglasii* ssp. *parviflora*), dwarf downingia (*Downingia pusilla*), and Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*) are more common (C. Patterson, unpubl. field data). All of these species are also restricted to seasonal wetlands. There are also several uncommon plants that grow in upland habitats on the Plain, including hayfield tarplant, the inland form of Tiburon tarplant, Gray's clover, and historically, showy Indian clover. This last plant was previously believed to be extinct, but was recently rediscovered at one location near the coast.

While Table 2 lists numerous sensitive plants from the general central Sonoma County region, it includes many (e.g., manzanitas and ceanothus) that are restricted to rocky (chaparral) soils and/or foothill environments (or serpentine, outcrops, barrens) which are essentially absent from the Santa Rosa Plain study area. Others are known from near the Plain, such as at the Kenwood Marsh (*Sidalcea oregana* ssp. *valida*) and around Sebastopol, while a few on the list are more widespread species that could possibly find suitable habitat here (e.g., *Legenere, Fritillaria, Campanula, Rhynchospora, Gratiola heterosepala*).

2.3.3 Wildlife Species of Concern

Threatened and endangered animals known or expected to occur in the study area are listed in Table 4. The California yellow-billed cuckoo is a state and federally listed bird associated with mature riparian forest. It historically inhabited the Laguna in the past, but was last observed in the 1950's before channelization eliminated most of its habitat. Re-establishment of the yellow-billed cuckoo would be dependent on restoration of large expanses of riparian forest. The bald eagle and peregrine falcon, state and federally listed species, are occasionally present in the Laguna (Bolander in De Mars et al., 1977). Other birds of special concern (on a DFG watch list) known to use the study area include the northern harrier (marsh hawk), burrowing owl, and black shouldered kite (Remsen, 1978).

The California freshwater shrimp (*Syncaris pacificus*) is a state and federally listed aquatic invertebrate species. It is currently found in Blucher Creek and several other tributaries of the Laguna. The freshwater shrimp was found in Santa Rosa Creek until 1960, when the creek was channelized. The Laguna de Santa Rosa is the type location for the freshwater shrimp which was first described in 1895. It was last found in the Laguna prior to 1950 (Cox, pers. comm.), and still has the potential to occur there.

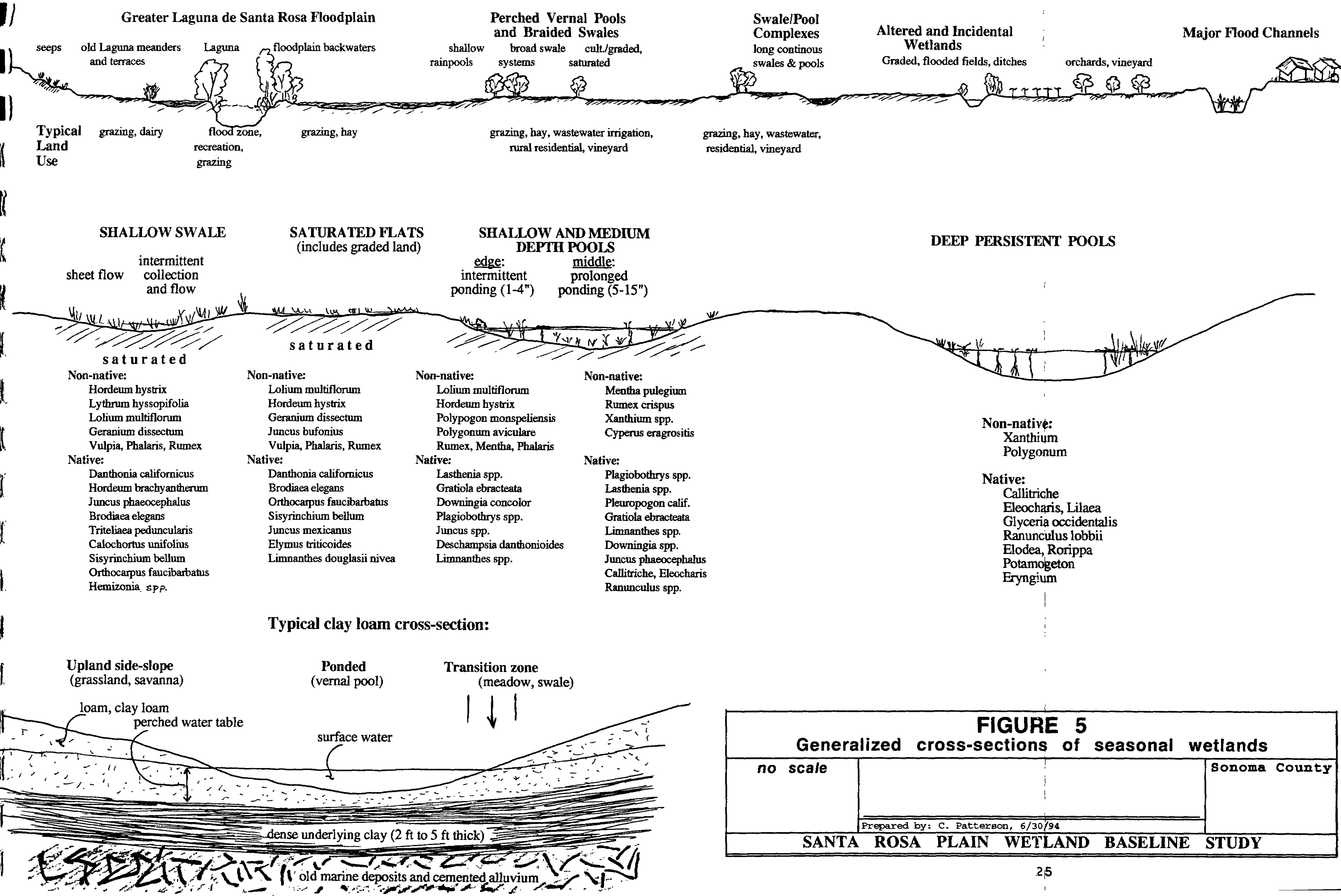

FIGURE 5

Generalized cross-sections of seasonal wetlands

no scale	Prepared by: C. Patterson, 6/30/94	Sonoma County

SANTA ROSA PLAIN WETLAND BASELINE STUDY

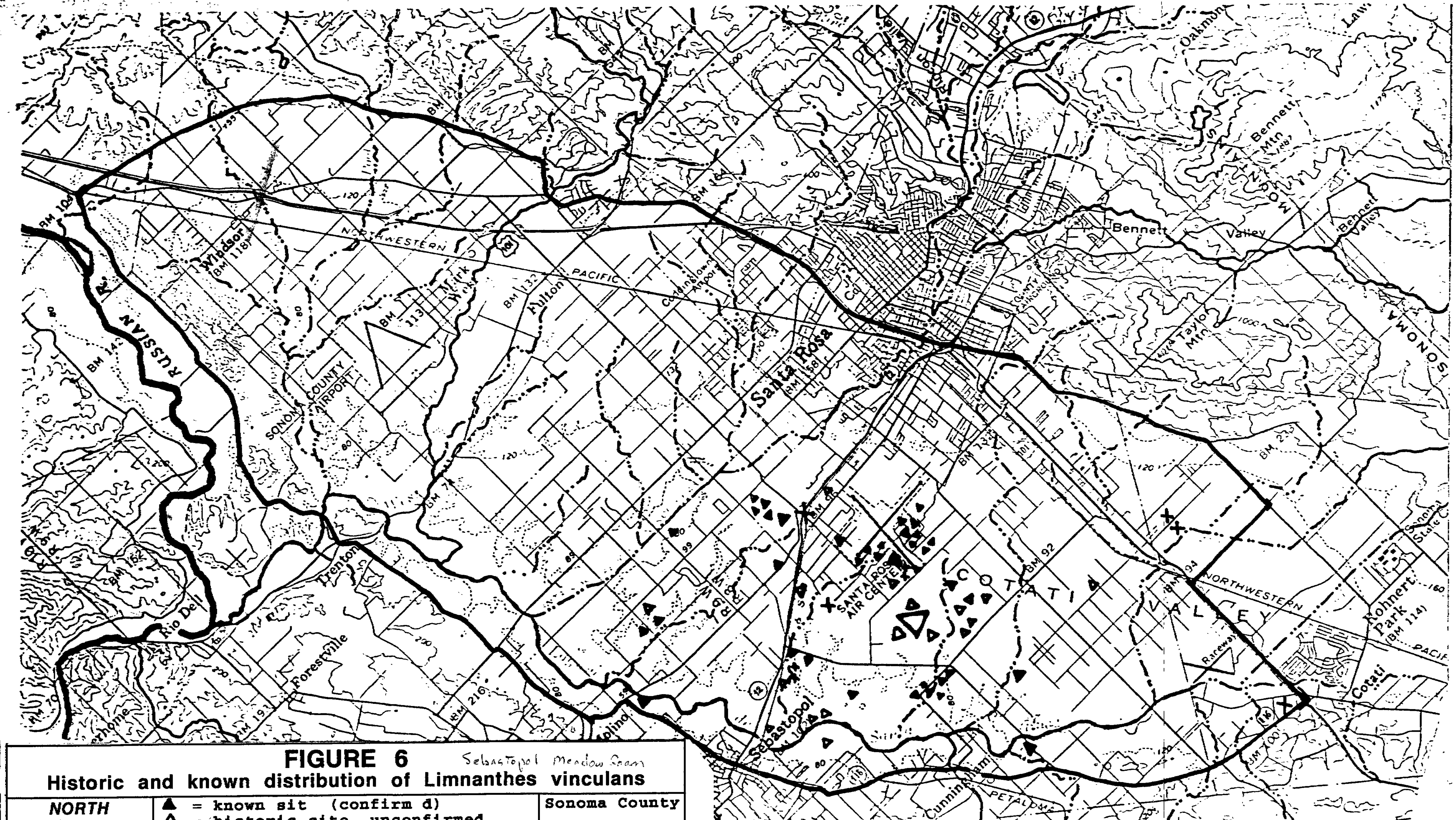

FIGURE 6

Sebastopol Meadow foam

Historic and known distribution of Limnanthes vinculans

NORTH	▲ = known sit (confirm d) △ = historic site, unconfirmed x = historic site, extirpated	Sonoma County
	Prepared by: C. Patterson, 6/30/94	

SANTA ROSA PLAIN WETLAND BASELINE STUDY

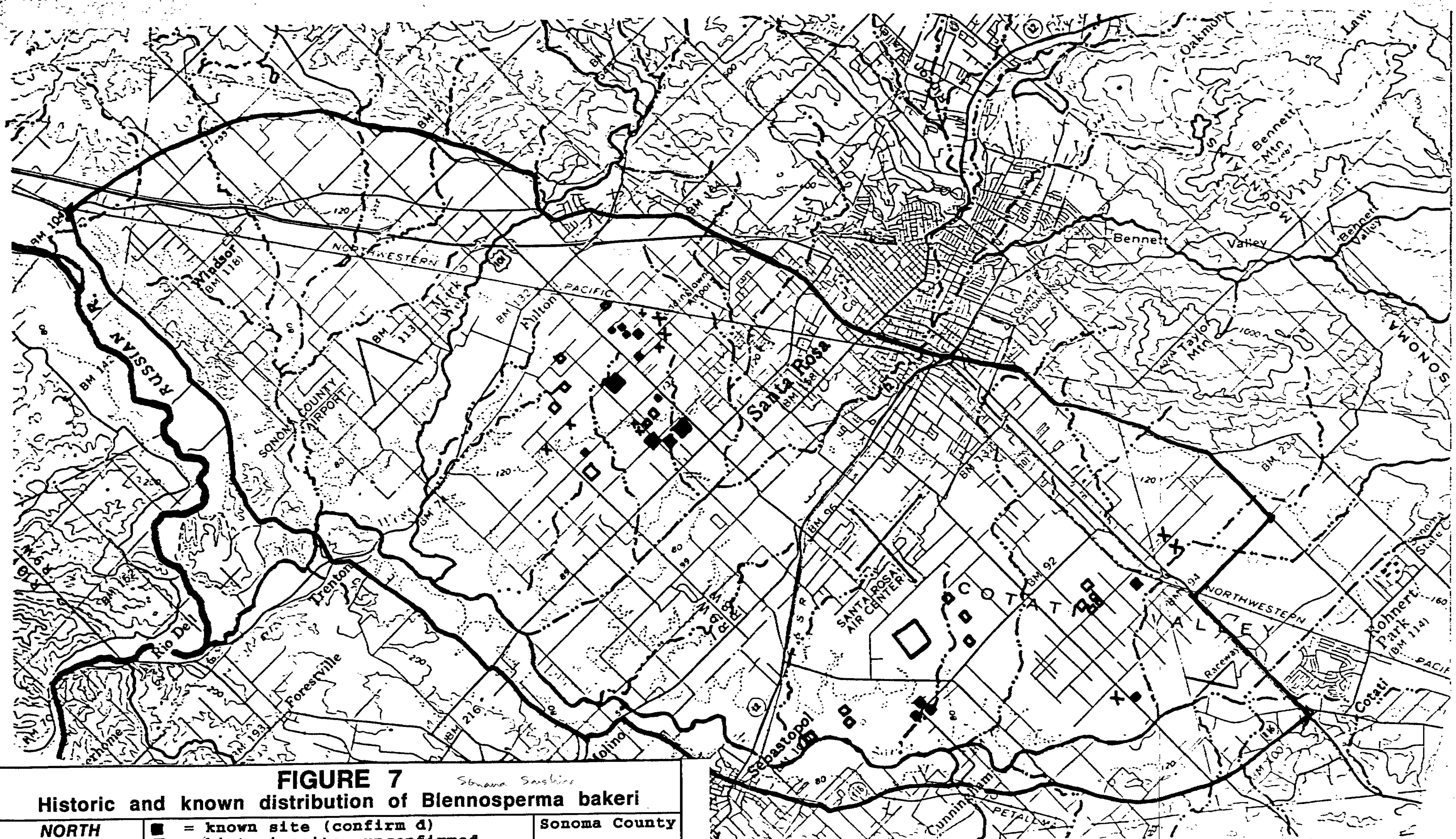

FIGURE 7

Sonoma Sunshine

Historic and known distribution of Blennosperma bakeri

NORTH

■ = known site (confirm d)
□ = historic site, unconfirmed
x = historic site, extirpated

Sonoma County

Prepared by: C. Patterson, 6/30/94

SANTA ROSA PLAIN WETLAND BASELINE STUDY

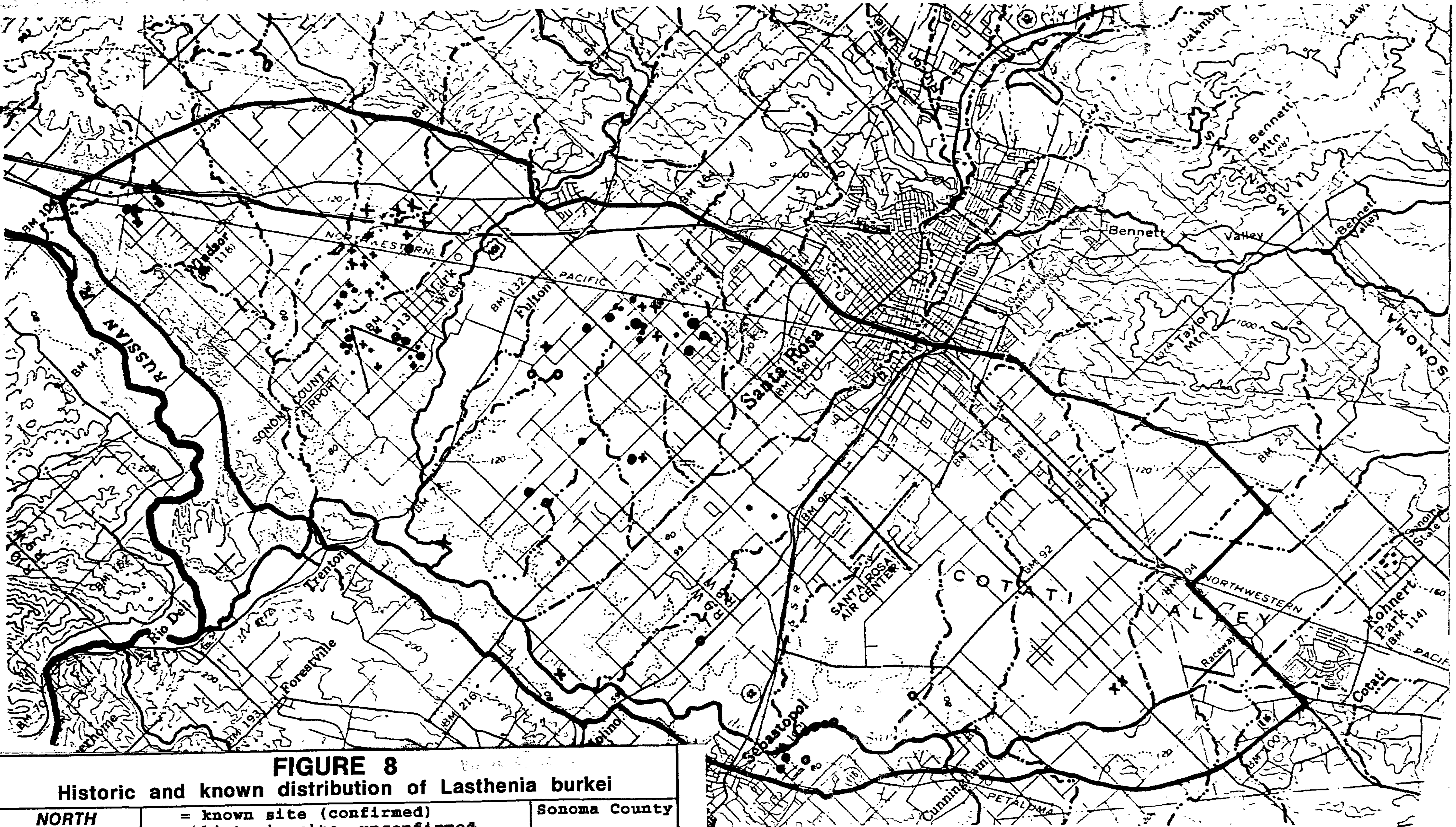

FIGURE 8

Historic and known distribution of Lasthenia burkei

Sonoma County

NORTH

= known site (confirmed)
o = historic site, unconfirmed
x = historic sit , xtirpated

Prepared by: C. Patterson, 6/30/94

SANTA ROSA PLAIN WETLAND BASELINE STUDY

Plate 5. Sebastopol meadowfoam (*Limnanthes vinculans*)

Plate 6. Baker's blennosperma (*Blennosperma bakeri*)

Plate 7. Burke's goldfields (*Lasthenia burkei*)

Plate 8. Many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha*)

At least two aquatic wildlife species that have recently been proposed for federal listing and protection are known to occur in the study area. These are the California tiger salamander (*Ambystoma californiense*) and California linderiella (*Linderiella occidentalis*). The tiger salamander breeds in vernal pools and retreats into subterranean burrows in the nearby grassland during summer. The larvae hatch and grow in the seasonal pools, typically in the deeper features and those that stay ponded for more than about three months, but occasionally in small pools that are less than 15 inches deep. The local genetic representation of this species is apparently relatively distinct (Shaffer, 1992), although Shaffer also reports that non-native tiger salamanders appear to be present in this region as well. At least 10 locations for this rare amphibian are known in the study area (FEMA, Broadmoor north, Air Center north, Finley at Wright, "Madera", "Springfield", "Cramer", Ludwig ditch, south of Ludwig and Wright, "Harotounian" on Scenic), although there is substantial additional potentially suitable habitat present that has not been surveyed. Tiger salamanders are threatened in the region by continued wetland losses, discing of upland refuge/burrow areas, and probable predation on larvae by mosquito fish and crayfish.

California linderiella is a diminutive (about one-half an inch long) aquatic invertebrate, a fairy shrimp, that lives in seasonal pools and slow waters. It typically hatches in early winter (November/December) from dormant eggs laid in the previous year's pools, and thrives in the colder early season water. In a wet year, it may go through more than one reproductive cycle, but generally by April, warmer temperatures and receding water triggers final egg production and dormancy until the next winter. The early season maturation of this species apparently minimizes the depredation by other aquatic species which mature later in the season. California linderiella has been found on at least six sites in the study area and could occur in many other pools. The natural seasonal wetlands of the Santa Rosa Plain appear to have included extensive suitable habitat for this species, i.e., shallow vernal pools and deeper swales, but extensive discing, manure input, exotic grass growth and thatch accumulation have rendered most unsuitable. At the time of writing this report, California linderiella had just been dropped from consideration for federal listing.

Other wildlife species of concern on the Plain include numerous wetland dependent birds and raptors (both residents and migrants), plus several reptiles (western pond turtle) and amphibians (red-legged frog, spadefoot toad) which could occur in the region, but which have not been well-documented here to date. Most of these species require more permanent water, however, unlike the conditions found in vernal pools. Detailed surveys for either common or sensitive wildlife species have generally not been conducted until recent years, and current regulatory requirements and accepted survey protocols have not been formally specified.

2.4 Historic Botanical Investigations

2.4.1 Early Botanical Work

Sonoma County's rich botanical diversity encouraged botanists from many countries to collect specimens of the native flora. Archibald Menzies arrived from Scotland in 1792. John M. Bigelow collected in Santa Rosa in 1854 and William H. Brewer in Santa Rosa, Sonoma, and Petaluma in 1862. Among Bigelow's collections is *Carex albida* at the type locality near Santa Rosa Creek. From 1880 to 1896, Joseph Congdon collected a number of wetland species on or near the Santa Rosa Plain, including *Alopecurus aequalis* var. *sonomensis* at Bloomfield Marsh, *Triteleia peduncularis* near Santa Rosa, and *Camassia quamash* near Sebastopol. In 1902, *Downingia concolor* was collected by Amos A. Heller and H. F. Brown near Santa Rosa. Alice Eastwood of the California Academy of Sciences collected frequently with J. T. Howell in this area. Included in their 1936 collections was *Pogogyne douglasii* ssp. *parviflora*, collected two miles north of Windsor. Milo S. Baker, curator of the herbarium at the Santa Rosa Junior College from 1922 to 1961, made many collections in Sonoma County. Frequently accompanied by John Howell, he enriched his large collection of specimens, many of them collected in the Vine Hill Region, Hood Mountain, Rincon Valley, and the Santa Rosa Plain. Although he located *Blennosperma bakeri* in Sonoma in 1946, he apparently was unaware of the species' western extension into the Cotati Valley (Santa Rosa Plain).

Table 4. Sensitive wildlife species potentially in the Santa Rosa Plain region

Wildlife Species	Status	Habitat	Likely In Study Area ?
BIRDS			
Accipiter cooperi . (Cooper's hawk)	CA: csc; FED: -	heavily wooded areas along streams or near springs	occasional foraging in wooded areas
Accipiter gentilis . (northern goshawk)	CA: csc; FED: C2	middle and high elevation forests	rare foraging or passing through
Accipiter striatus . (sharp-shinned hawk)	CA: csc; FED: -	heavily wooded areas along streams or near springs	occasional foraging in wooded areas
Agelaius tricolor . (tricolored blackbird)	CA: csc; FED: C2	nests in cattails, blackberry etc. near perennial streams and/or marshes	unknown; suitable habitat present along the Laguna
Aix sponsa . (wood duck)	CA: -; FED: -	slow moving rivers and streams with riparian thicket or woodland	unknown; suitable habitat present along the Laguna
Aquila chrysaetos . (golden eagle)	CA: csc; FED: -	nests in tall trees with views or on cliffs; forages in open grasslands, etc.	occasional foraging in open areas; possible nesting
Ardea herodias . (Great blue heron)	CA: -; FED: -	major wetlands, sloughs, creeks, shallow lakes, ditches	Yes; suitable habitat present along the Laguna
Asio flammeus . (short-eared owl)	CA: csc; FED: -	fresh, brackish, and saltwater marshes, lowland meadows, grassland	unknown; suitable habitat present along the Laguna
Asio otus . (long-eared owl)	CA: csc; FED: -	hunts in open grasslands, meadows, fields; nests in thickets and woodlands	unknown; may be suitable foraging habitat
Casmerodius albus . (Great egret)	CA: -; FED: -	major wetlands, sloughs, creeks, shallow lakes, ditches	unknown; suitable habitat present along the Laguna
Circus cyaneus . (Northern harrier)	CA: csc; FED: -	meadows, marshes, grasslands, open fields	Yes; extensive suitable habitat; frequent in open fields, near wetlands
Coccyzus americanus . (yellow-billed cuckoo)	CA: E; FED: -	riparian woodland and forest in major valleys, along major rivers	No; historic, but no suitable large habitat patches remain
Dendroica petechia . (yellow warbler)	CA: csc; FED: -	riparian woodlands	unknown; suitable habitat present along the Laguna
Egretta thula . (snowy egret)	CA:-; FED: -	nests in groves of trees near wetlands with fish and/or suitable food base	unknown; suitable habitat present along the Laguna
Elanus caeruleus . (Black-shouldered kite)	CA: FP; FED: -	meadows, marshes, grasslands, open fields	occasional; extensive suitable habitat
Falco columbarius . (merlin)	CA: csc; FED: -	winter migrant; forages in grasslands, wetlands, etc.	unknown; suitable habitat present
Falco mexicanus . (prairie falcon)	CA: csc; FED: -	nests on cliffs; forages in open country	occasional passing through, foraging

Table 4. Sensitive wildlife species potentially in the Santa Rosa Plain region

Wildlife Species	Status	Habitat	Likely In Study Area ?
Falco peregrinus anatum . (American peregrine falcon)	CA: E ; FED: E	nests on cliffs near permanent water	unknown; not much habitat
Haliaeetus leucocephalus . (bald eagle)	CA: E; FED: E	nests in large trees or snags near permanent water; needs fish for foraging/residency	occasional migrant?
Icteria virens . (yellow-breasted chat)	CA: -; FED: -	dense riparian thickets, scrub	unknown; suitable habitat present
Nycticorax nycticorax . (black-crowned night heron)	CA: -; FED: -	feeds in marshes; nests in riparian scrub to forest	unknown; suitable habitat present
Pandion haliaetus . (osprey)	CA: csc; FED: -	nests on snags, poles, towers, very tall trees; near permanent water with fish	occasional migrant?
Progne subis . (purple martin)	CA: csc; FED: -	nests in holes in snags, stumps, near permanent waters with insects	unknown; suitable habitat present
Speotyto cunicularia . (Burrowing owl)	CA: csc; FED: -	creekbanks, low hills, grasslands	unknown; suitable habitat present
MAMMALS			
Bassariscus astutus . (ringtail cat)	CA: FP; FED: -	riparian scrubs, woodland; typically near permanent water	unknown
Plecotus townsendii townsendii . (Townsend's western big-eared bat)	CA: csc; FED: C2	many habitats; needs caves, mines, or old buildings for roosting	unknown
Taxidea taxus . (American badger)	CA: csc; FED: -	oak savanna, grassland	Yes; some open habitat, but few undisturbed burrow sites
REPTILES AND AMPHIBIANS			
Ambystoma californiense . (California tiger salamander)	CA: csc; FED: FPE	vernal pools, seasonal ponds, isolated ponds & small lakes	Yes; scattered sites in seasonal wetlands, ponds
Clemmys marmorata pallida . (western pond turtle)	CA: csc; FED: C2	ponds and perennial streams	unknown; suitable habitat along the Laguna
Rana aurora draytonii . (California red-legged frog)	CA: csc; FED: PFE	perennial streams	unknown; possibly suitable habitat along the Laguna
Rana boylei . (foothill yellow-legged frog)	CA: csc; FED: C2	creeks, streams in woodland, chaparral	unknown; possibly suitable habitat along the Laguna
INVERTEBRATES			
Branchinecta lynchi . (vernal pool fairy shrimp)	CA: -; FED: FPE	vernal pools, seasonal waters	unknown; none documented to date; habitat present

Table 4. Sensitive wildlife species potentially in the Santa Rosa Plain region

Wildlife Species	Status	Habitat	Likely In Study Area ?
Danaus plexippus . (Monarch butterfly)	CA: -; FED: -	tree groves, occasionally in eucalyptus	occasional
Ischnura gemina . (S. F. forktailed damselfly	CA: csc; FED: C2	slow moving freshwater with dense vegetation, often near brackish marshes	unknown; none documented to date; habitat present
Lepidurus packardii . (vernal pool tadpole shrimp)	CA: -; FED: FPE	vernal pools, seasonal waters	unknown; none documented to date; habitat present
Linderiella occidentalis . (California linderiella)	CA: -; FED: -	vernal pools, seasonal waters	Yes; scattered sites in seasonal wetlands
Proceratium californicum . (valley oak ant)	CA: -; FED: C2	valley oak woodland, riparian woodland	unknown; none documented to date; habitat present
Smithistruma reliquia . (ancient ant)	CA: -; FED: C2	valley oak woodland, riparian woodland	unknown; none documented to date; habitat present
Syncaris pacifica . (California freshwater shrimp)	CA: E; FED: E	cool shaded streams, natural creekbanks	Yes; in scattered natural creeks

Source: California Department of Fish and Game, 1992, List of Special Animals

CA (California status): E = Endangered, R = Rare, T = Threatened, FP = fully protected, csc = species of special concern

FED (Federal status): E = Endangered, R = Rare, T = Threatened, FPE = federally proposed C1 = Candidate, Category 1 (information sufficient to make decision on listing, may warrant listing), C2 = Candidate, Category 2 (information insufficient to make decision on listing, may or may not warrant listing)

Peter Rubtzoff, well known for his Phytogeographical Analysis of Pitkin Marsh published in 1953, had a deep interest in wetland plants and collected extensively in seasonal and perennial wetlands in the study area. It was not until the early 1970s, however, when the Russian River/Cotati Intertie was in the planning stages that native plant issues and rare plant concerns became part of the planning process. Recognizing the potential for accelerated population growth in the Santa Rosa area and its impact on native vegetation, a local chapter of the California Native Plant Society was organized in 1971/1972. In March of 1972, the group obtained its charter and began to focus public attention on the problems and issues involving native (and in particular rare and endemic) plant species.

2.4.2 Historic Accounts of the Plant Species of Concern

There are several different levels of official and unofficial status for plants in the regulatory scheme for this region. The first recognition of plant taxa as being potentially rare or endangered, here and elsewhere in the state, arose from early efforts by the California Native Plant Society (CNPS) to identify, investigate, and prioritize such species into various lists for planning and conservation purposes. From the initial published CNPS lists of 1974, the CNPS Inventory has grown into a major source of information on rare plants in California and has served as a potential candidate list for state and federal agencies. Based on the most recent edition of the CNPS inventory (Skinner and Pavlik, 1994), there are approximately 122 sensitive plant taxa known to occur in Sonoma County, about 20 of which are known or could be expected to occur on (or in close proximity to) the Santa Rosa Plain. Of these, most are known to occur in wetland habitats.

The three primary plant species of highest concern and status that occur in the study area are Sebastopol meadowfoam, Burke's goldfields, and Baker's blennosperma. Appendix B gives more detailed descriptions of these three species. The following are brief accounts of the collection histories for these plants:

Sebastopol meadowfoam (*Limnanthes vinculans* Ornduff) has been collected on the Santa Rosa Plain since 1946, but it was not described until 1969 (Ornduff, 1969). The formal description and discussion of the species' biosystematic relationships with other members of the genus were based primarily on Peter Rubtzoff's collections from 1954-1966 combined with Ornduff's field work in 1965-1966. Sebastopol meadowfoam was regarded as a Sonoma County endemic from 1969 until 1992 when a small disjunct colony of this species was discovered in Napa County.

Several populations of this species in the study area have been monitored frequently since 1974. In 1980, populations were known to occur in 17 locations on lands accessible for botanical surveys (Lovell, 1980). Continuing surveys have resulted in the discovery of additional colonies, and the current total (based on this investigation; see Attachment 1) of known Sebastopol meadowfoam locations that occur under separate land ownership is approximately 55. Hydrologically separate populations, however, number about ten. Of the 55 currently reported or known occurrences in Sonoma County, four are erroneous, ten or more are considered extirpated, at least eight are in preservation, 20 are considered extant but may not be large enough to qualify as good preserve lands, about ten are extant but threatened by development, and eight are large enough to qualify as viable preserves providing adjacent hydrology and land use are compatible. At least seven are ensemble sites, containing more than one listed species.

Baker's blennosperma (*Blennosperma bakeri* Heiser), also referred to as Baker's sticky-seed or Sonoma sunshine, was first discovered in a "hog wallow" in the town of Sonoma on April 2, 1946 and was described in 1947. Subsequently, additional colonies were located approximately four miles south of El Verano by Roderick in 1961 and Ornduff and Heckard in 1964. From 1972 to 1975 some of the Sonoma colonies were stable, but at least one was extirpated in 1977 by grading and an historic site on Arnold Drive was converted to vineyards in 1975.

Other locations of this species include a large colony discovered in 1986 north of Bonneau Road west of Arnold Drive by Jack and Betty Guggolz (the adjacent lands have since been converted to vineyard) and a small population in Sonoma Valley Regional Park by Stephen Barnhart in 1982.

Baker's blennosperma was not known on the Santa Rosa Plain until 1974 when it was discovered near Todd Road by C. Quibell, Nancy Harrison, and Betty Lovell (now Guggolz). Annual monitoring documented the stability of the population for several years. Following a change in property management coupled with several years of drought, the blennosperma abundance has declined. In 1977, as mitigation for the anticipated loss of several vernal pools in the area by the construction of the proposed Santa Rosa Regional Wastewater System, the City of Santa Rosa set aside the 75 acre area in the northwest quadrant of the intersection of Todd and Llano Roads. The parcel was subsequently sold to the California Department of Fish and Game to protect the existing populations of several rare plants, including *Blennosperma bakeri, Limnanthes vinculans, Lasthenia burkei, Pogogyne douglasii* ssp. *parviflora, Perideridia gairdneri* ssp. *gairdneri and Ranunculus lobbii. Lasthenia burkei* was last confirmed on the parcel in 1980 (C. Patterson, unpubl. field data) and may have been extirpated there. Experimental management options are currently being studied to restore the vigor of the native and rare plant species populations.

The number of historically known blennosperma populations under separate property ownerships is estimated at approximately 60, although many of these are hydrologically connected. Based on the findings of this study (see Attachment 1), it is estimated that there are less than 12 biologically separate populations remaining. Of the approximately 60 occurrences, about 26 are considered extant, ten or more are believed to be extant but are threatened with development, at least 17 have been extirpated, and seven have not been confirmed recently (B. Guggolz, pers. comm.). Of the 26 extant populations, four are in preservation and six are relatively large and contained within single parcels. Five of these latter properties are on the Plain and several are "ensemble" sites (with multiple sensitive species).

Burke's goldfields (*Lasthenia burkei* (Greene) Greene) was first described as *Baeria burkei* by Greene in 1886. Keck (1959) and Abrams and Ferris (1960) treated *B. burkei* as a synonym of *B. fremontii*. In 1966, Ornduff combined *Baeria, Crockeria* and *Lasthenia* under the genus *Lasthenia* and recognized *Lasthenia burkei* as a distinct species. This species is endemic to the North Coast Ranges of California, the type specimen collected "near Ukiah, in Mendocino County in 1866, by J.H. Burke. The type locality site has not been reconfirmed and is presumed extirpated. Two populations are known to occur in Lake County, and numerous colony locations are present on the Santa Rosa Plain. In recent genetic studies (Huntington, 1992/93), preliminary findings indicate that 3 genetic races of the species may exist: (1) the Lake County population, which exhibits variation in the number of awns on the achenes; (2) the northern Santa Rosa and Windsor populations; and (3) the robust specimens that occur on the southern Santa Rosa Plain near the Laguna de Santa Rosa.

Burke's goldfields is currently known from a single small colony north of Healdsburg, south from Windsor to the Laguna, with the southernmost known natural colony at the Todd Road Preserve. This latter population has not been reconfirmed, however, since 1987 and may be extirpated here.

Early collections by Ornduff (1960) documented a population "1.3 miles north of East Windsor on Highway 101. Rubtzoff collected the species "near the Laguna de Santa Rosa east of Graton, between Occidental and Guerneville Roads" in 1966 and again "near the Laguna de Santa Rosa northeast of Graton at the end of Piner Road" in 1969. The 1966 population was reconfirmed by Rubtzoff during a 1974 CNPS field trip, but by 1977, agricultural land use changes had eliminated both of the northern Laguna de Santa Rosa populations. In 1973, the local CNPS chapter began monitoring the Burke's goldfields populations. N. Harrison reconfirmed populations in northern Windsor in 1979. In 1984, an aerial flight by C. Patterson (confirmed by subsequent by ground checks) discovered several other goldfields colonies in the Windsor area. From 1986 on, Guggolz and Guggolz monitored most of the northern Windsor populations annually, and the Waaland study in 1988/89 reconfirmed many sites.

Historically, approximately 30 occurrences of Burke's goldfields have been known to occur in the Windsor area, from the southern edge of the Sonoma County Airport to north of Arata Lane. Of the 30, 22 are considered extirpated by urban and commercial development or as a result of agricultural land use changes. Included were two of the largest populations in the County. At the present time, only a few stable populations remain in the northern Windsor area. These are potentially threatened by urban development.

Approximately 85 *Lasthenia burkei* sites under separate land ownership have historically been reported in the study area. These occurrences represent approximately 18 separate biological populations. Of the 85 occurrences (based on this study), approximately 30 are considered extirpated and ten have some type of preserve designation. Of the extant populations, several have not been reconfirmed for a number of years and their current status is unknown. At least nine of the sites are or have historically been ensemble sites.

2.5 Ensemble Sites

While the pristine landscape probably supported a rich blend of vernal pool, meadow, and grassland species with much greater total area and continuity, there are currently only a few sites where more than one of the primary sensitive plants occur together. While a single species occurrence, or even just the presence of suitable vernal pool habitat generally represents a potentially significant resource and possible constraint on land use, multiple occurrences are scarce, indicative of especially valuable habitat conditions, and are generally regarded here as being of higher overall quality and importance. Appendix D provides a summary list of the surveyed sites with sensitive plants, including a preliminary indication of the more significant (e.g., ensemble) locations.

As additional detailed wetland surveys are conducted, it is likely that more ensemble sites will be found. This is likely to include communities with both sensitive plants and animals, such as several sites in southwest Santa Rosa which support tiger salamanders, California linderiella, and Sebastopol meadowfoam.

2.6 Resource Threats and Land Use Trends

On the Santa Rosa Plain, similar to the rest of the state, vernal pool habitat losses have been significant and have occurred due to both direct physical alteration and indirect effects (Airola and Messick, 1987; Waaland, 1989). Direct impacts to vernal pool habitat have come about as a result of land conversion to agriculture and urban development, as well as through stream channelization projects, irrigation, and the draining and filling of wetlands. Indirect impacts such as hydrological modifications, exotic species invasions, crop or stocking rate changes, and long term discing practices are more subtle and usually require longer periods of time to become evident, but have also had severe impacts on the regional habitat mosaic, flora and fauna. The following are brief discussions of land uses which have had and/or continue to affect the study area's vernal pools and related wetlands:

2.6.1 Land Conversion

Previous studies (Waaland et al., 1990) identified 12,000 acres (out of a 28,000 acre study area) of the Santa Rosa Plain have been converted to urban, cropland and orchard or vineyard. The habitat type most severely affected has been the oak woodland/savanna-vernal pool complex, which has the appropriate topography and soils for both agriculture and housing construction. Native biodiversity under these land uses is largely lost as a result of agricultural management (weed and pest abatement) practices or standard urban landscaping.

Urbanization - One of the two most important sources of change in the study area has been the conversion of natural habitats into urban situations. Roughly 25 percent (7,000 acres) of the 28,000 acre study is occupied by residences, subdivisions, rural ranchettes, golf courses, commercial buildings, and other forms of urban development. Conversion of the natural landscape (including wetlands) to urban use is generally complete and essentially irreversible, and involves all manner of disturbances, from hydrological and topographical alterations, to the installation of lawns and ornamental landscaping.

Agriculture - The second greatest source of land conversion stems from agricultural development and use. Approximately 3,800 acres of the 28,000 acre study area were identified as orchard and vineyard, and 1,000 acres are cropland (Waaland et al., 1990). Together, these intensive agricultural uses have converted 17 percent of the study area. Additional land in the study area is planned for vineyard expansion in the future.

2.6.2 Channelization

Another source of direct impacts to the valley ecosystem in general and the wetlands in particular stems from channelization of natural waterways. Streams channelized for flood control, such as Roseland and Colgan creeks, have been excavated through existing vernal pool terrain, interrupting hydrologic connections and filling wetlands with sidecast dredge spoils. While not studied in detail, such channelization is also likely to have a general dewatering effect on the overall landscape.

2.6.3 Filling and Draining of Wetlands

In the past, another source of impact has been filling and draining of seasonal pools for mosquito abatement purposes, making the habitat unavailable to migratory waterfowl and many plants. Both practices make conditions more favorable for pasture grasses at the expense of native plants. The placement of varying amounts of fill on private properties has been extensive over the years, including ranchers creating high ground for livestock to escape wet feet in winter, local improvements to and leveling of individual lots and gardens, and the disposal of excavated or graded material. Based on air photo analyses and reconnaissance surveys, low level backyard filling, both through onsite reconfiguration and the importation of fill continues without review or authorization on a small scale throughout the study area (C. Patterson, unpubl. field data).

2.6.4 Grazing

Since the arrival of Spanish colonists in the late 1700s, the Santa Rosa Plain has been subjected to the influence of grazing by domestic cattle, horses and sheep. Along with these animals came a host of introduced (non-native) plants which originated in Europe, Asia, and Africa. The combined effects of grazing by domestic herbivores and invasion by non-native plants has led to the indirect replacement of the native bunchgrasses and wildflowers with non-native annual grassland. These influences have also contributed to the decline in valley oak woodland, largely because regeneration is negligible where seedlings can be grazed. Despite the grazing pressure, many vernal pools under this management continue to support native species because most weeds cannot tolerate the hydrological conditions associated with the pool habitats. Grazing under typical stocking rates and schedules for this region is not especially compatible with the native vernal pool flora, although light grazing, particularly by horses, has been shown to work well with at least Burke's goldfields. Light grazing can be used to reduce thatch and keep the competing grasses at a minimum, both beneficial to the native flora, but heavier use almost invariably results in injurious trampling, direct plant consumption, local soil compaction, and physical damage to plants attempting to mature and set seed. Higher rates of use also tend to contribute excessive manure to the system with detrimental effects on water quality, biological productivity, and diversity.

2.6.5 Irrigation

Compared to grazing, the introduction of wastewater irrigation is recent, beginning in the 1970s. The effects on the valley ecosystem include a loss of oak woodland and a change in the plant composition of vernal pools. The effects of irrigation profoundly affect native pool species because they have evolved under a summer-dry Mediterranean climate. Application of irrigation during the summer alters the water regime of the soil, often creating perennial wetland conditions not tolerated by the native vernal pool flora. In upland areas, the standard seed mix of pasture grasses and clovers has largely replaced the native wildflowers and bunchgrasses.

Irrigation of the naturally summer-dry valley oak savanna has also been implicated in increased mortality of trees. The prolonged moisture regime in summer makes conditions more favorable for attack by root fungus (*Armillaria mellea*) (Gross and Schmidt, 1989), and preliminary results of studies of irrigated oak savanna on the Santa Rosa Plain show accelerated loss of oak trees on lands under irrigation relative to unirrigated areas. The data indicate (Waaland et al., 1990) that after the onset of irrigation (1977), oak tree loss on irrigated lands was over five times greater than on unirrigated lands. Approximately 1,300 acres of unirrigated oak woodland remain, approximately six percent of its original extent. The remaining oak savanna areas constitute much of the available land planned for irrigation expansion. The other significant available acreages are composed of annual grassland-vernal pool complex in the south half of the study area and altered seasonal wetlands west of Rohnert Park.

To meet the demand for wastewater disposal, the Sub-regional Sewage Treatment System requires at least 100 additional acres of land on the Santa Rosa Plain annually. Growth in Windsor will add pressure to the Windsor Water Direct to expand reclaimed water irrigation to at least 1,000 acres in the northern part of the study area in similar habitats. The Sonoma County Airport area is already used extensively for wastewater irrigation, and the local sewage treatment plant continues to seek expansion of its irrigated acreage in this part of the study area. The ongoing need to expand effluent irrigation acreage to keep pace with population growth will continue to jeopardize the existence of oak woodlands and vernal pools on the Santa Rosa Plain unless other, less sensitive lands are found for irrigation or other means of disposal are found.

Plate 9. Wetland areas in private rural ownership are often used for livestock grazing, trash deposition, and other potentially disruptive activities.

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